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GOVERNMENT OF THE PROVINCE OF ALBERTA

DEPARTMENT OF WATER RESOURCES

SURVEYS OF THE

NORTH SASKATCHEWAN RIVER - 1910-1915

BY

Government of Canada

DEPARTMENT OF PUBLIC WORKS

L. R. VOLIGNY

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DIRECTOR

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District Engineer's Office P.W.D.

Prince Albert, Sask., November 25th, 1917

Eugene D. Lafleur, Esq.

Chief Engineer

Department of Public Works

Ottawa, Ont.

Sir:-

I have the honour to transmit herewith a Report of the Survey of the North Saskatchewan River executed under my charge in accordance with instructions dated May 28th, 1910.

The purpose of the Survey was to ascertain the feasibility and cost of providing a navigable waterway for light draught vessels from Edmonton to Lake Winnipeg.

To carry on this investigation, a staff of Engineers and Assistants was employed in the field during the summer months, from June 1910 to October 1915.

The charts, plans, diagrams, tables, etc., accompanying the Report will readily show the information and data on which the results of the survey are based. These results may be summarized as follows:-

(1) It is feasible to create a navigable waterway for light draught vessels from Edmonton to Lake Winnipeg;

(2) Such an undertaking would necessitate improvements covering 941 miles of River, at an estimated cost of $20,765,591.00.

(3) A channel 150 feet wide and 6 feet deep at low water will meet the requirements of present and prospective navigation between Edmonton and Le Pas;

(4) From Le Pas to Lake Winnipeg a channel of the same width but 10 feet deep will be necessary in order to insure safe navigation in that reach;

(5) The proposed improvements will consist of
(a) the dredging of the river bed and the removal of boulders in the rapids at an estimated cost of $4,839,597.00;
(b) the building of Diversion and Bank Protection Works in the upper river, estimated to cost $1,360,674.00;
(c) the construction of locks, dams and canals, the cost of which is estimated at $14,565,320.00;

(6) It is estimated that the minimum development of effective electrical power possible at sites between Prince Albert and Lake Winnipeg, where permanent structures are proposed, would total 30,300 Horse-Power;

(7) The control and regulation of excessive floods by means of storage reservoirs at headwaters of the Saskatchewan is essential to the success of this project. Any improvement scheme should not be considered unless the possibility of such regulation has been definitely established.

The report is expected to convey a general idea of the conditions met with on the Saskatchewan River as ascertained from actual surveys, and will show the character, purpose, and cost of works required to render the River navigable at the low stage of water prevailing during the season of navigation, from May to November of each year. Programs of dredging, plans of structures, specifications, etc., etc., are not embodied in the report, as it is thought the preparations of such details can be better attended to at a later date, when the carrying out of the project has been decided upon.

Respectfully submitted

(Sgd.) L.R. Voligny

Engineer-In-Charge

N.M.

S U R V E Y S

A summary of the surveys performed and results secured each season by the parties engaged in the field, from the inception of the survey in June 1910 to its completion in the fall of 1915, is given in the following:-

Season 1910

Reconnaissance. A preliminary reconnaissance of the River from Edmonton to Le Pas, covering a distance of 801 miles, was made during the summer, the purpose being to obtain needed information as to the River grade and channel bed generally, and more particularly to ascertain the location, nature and extent of obstructions to navigation such as rapids, shoals, shifting sand bars, boulder reefs, driftwood piles, etc. Reaches in which these were such as to necessitate special works for their improvement were examined and noted for further detailed surveys.

Launch. The small petroleum launch "Lafleur" built in Edmonton in the Spring of 1910 for this survey, was used for reconnaissance work. It served also for visiting river parties in the early season, conducting the survey, distributing supplies and for the establishing of water gauges along the route. It was laid up at Edmonton in August upon the return trip from Le Pas, having been found unsuited for river survey purposes. Canoes were used to complete the reconnaissance and to attend to the survey the remainder of the season, or until October when all parties were called in.

Gauges. Nine water gauges were established at the following points along the River:-

LOCALITY	MILE	LOCALITY	MILE	LOCALITY	MILE
Edmonton	0	Duvernay	124	Hewitts Ldg.	219
Battleford	328	Prince Albert	493	The Forks	531
Cumberland L.	726	Le Pas	801	Lake Winnipeg	941

Gauge readings were recorded at noon daily throughout the season of navigation, or from May to the freeze up in November.

Fluctuations of the River level at above named stations and at intermediate stations established in subsequent years during the progress of the Survey, are shown on Diagrams, Plates A-1, A-2.

Field Parties. The organization and equipment of field parties was effected during the latter part of June at Prince Albert and Edmonton, these being the two main points from which the survey was conducted. The staff of assistants, rodmen, chainmen, boatmen and labourers, numbering 50 men, was formed into eight parties composed as follows:- four levelling parties of six men; two transit parties of eight men, one Contour Party of five men and one Reconnaissance and supply party of 5 men (Launch "Lafleur").

Field Parties were assigned to the several sections of river into which the Survey was divided and reached their destinations by canoe during the early part of July, from which time surveys were carried on continuously until the cessation of work on the 1st of October.

Levelling. The distance between Edmonton and Le Pas (801 miles) was divided into approximately equal sections among the four levelling parties. Section No. 1 extending from Edmonton to Vermillion River at Lea Park (194 3/4 miles). Section No. 2 from Vermillion River to the Canadian Northern Railway Co's bridge at the Elbow or Ceepee (198½ miles). Section No. 3 from Ceepee to the Head of the Cadotte Rapids (197 3/4 miles) and Section No. 4 from the Cadotte Rapids to Le Pas (210 miles).

Levellers were instructed to run two simultaneous or parallel lines and to set Bench Marks at intervals of 2 or 3 miles, care being taken to select points well above high water mark and at a safe distance from banks liable to

destruction by floods. The length of fore and back sights was limited to 400 feet. Measurement by pacing was adopted for equalizing sights so far as possible. Reprocical sights were employed in effecting crossings of the river, three or four pairs being taken from each side with improvised targets.

The rods in common use were graduated to hundredths, and on sight of normal lengths were not read closer than the half-hundredths. Care had to be exercised not to read the rod too close to the ground when refraction was considerable, as in the early morning, or to attempt levelling under unfavourable atmospheric conditions. The instrument was screened from wind and sun by an umbrella to eliminate atmospheric errors.

Two rodmen were used on each party. Each rodman carried 1" square iron pins, pointed at one end, 12 inches and 18 inches long, with an axe and rod. The order of recording sights was, first B.S., on high pin, then both F.S., lastly B.S. on low pin, check H.I., advance. Owing to this method, it is seen that one of the axemen stationed near the instrument with umbrella could, by carrying an extra set of pins, materially aid the progress of the party, receiving the pins from the rear rodman and advancing them to the forward rodman, usually during a "Set up", this rodman having already located and driven the set he carried, thus the forward rodman would not delay the advance of the party.

Temporary "Benches" were provided by cutting and trimming suitable trees such as poplars, spruce, large alders, frequently met with on the river banks, the stumps being protected by paint, and marked. Copper nails were driven in shelf hewn out for supporting rod at record elevation, and a flag or painted cross-head, nailed to a nearby tree, to indicate the position of each Bench Mark.

These were numbered independently on each of the four sections and roughly located with reference to township and section corners, Islands, and other prominent features.

The limit of divergence allowed between duplicate lines was e - 0.02 distance in miles, equivalent to 0.035 ft. for benches about three miles apart. Where parallel lines agreed within this limit, the mean of both lines was adopted as the Elevation of the Bench; in cases where the limit was exceeded, the line was re-run from the last Bench. Connections made since the completion of this survey with Precise Levels of the Topographical Surveys Branch of the Department of the Interior, at Edmonton, Battleford, Ceepee, Prince Albert, and Le Pas, show that this limit of divergence was well maintained.

A total of 659¼ miles of duplicate levels were run in 1910 and 247 Bench Marks established on the main line of levels. The condition of each section at the close of the season's work is given in the table below.

Sect.	Reach	Lgth. (Miles)	Miles run	BMs.	Miles to complete.
1	Edmonton to Vermillion River	194 3/4	177½	48	17¼
2	Vermillion R. to Elbow (Ceepee)	198½	136 3/4	48	61 3/4
3	The Elbow to Hd. of Cadotte Rap.	197 3/4	160 3/4	84	37
4	Cadotte Rapids to Le Pas	210	184¼	67	25 3/4
	Totals	801	659¼	247	141 3/4

The parties averaged 11 miles per week or about 2 miles per day for the entire season, which may be considered fair progress, in view of the broken nature of the Country along the River, and the delay due to the cutting out of lines, moving camps, etc. Owing to work being discontinued one month earlier than originally intended, the various sections could not be connected in 1910. The gaps, however, were closed the following year, a special levelling party having been detailed for the work.

Water Levels In addition to the reading of main gauges already referred to, water levels were taken at noon daily by each party opposite camp, and at the several Bench Marks, as they were being set up. Elevation of water at top and bottom of all rapids was also noted. From elevations thus obtained, a low water profile of the river was platted. See plate B.

Topography. Transit Party No. 1 started work 25 miles below Prince Albert, at the head of the series of rapids known as "La Colle Falls". A chain traverse of the reach, extending from the first rapid to "The Forks" - where both branches of the Saskatchewan River meet - was made, transit stations being connected, where possible, to section corner posts of Dominion Lands Surveys.

A detailed survey of the locality, with contours, was considered essential in view of probable works required to overcome the several rapids in this 13 mile reach. Work was completed in August, the party returning to Prince Albert, and afterwards proceeding up river, where it was engaged in locating Bench Marks, Ferry Crossings etc., as far as "The Elbow" until September, when it was called in and disbanded.

Transit Party No. 2 was detailed to survey the Cadotte, Nipawin, Tobin, and Squaw Rapids. The survey was divided into two sections: the first section 11 miles in length, comprising the Cadotte and Nipawin Rapids, the second section starting from the Head of the Tobin Rapids and extending 24 miles down to the Sturgeon River "Cut Off". Both sections, totalling 35 miles, were completed in 1910, excepting about ½ mile of river above the "Cut Off" which had to be abandoned owing to supplies being exhausted. The party proceeded down river from the "Cut Off"., calling at Cumberland House for supplies, and reached Le Pas the second week in September, when it was paid off.

Contours. Upon completion of the traverse of the "La Colle Falls" reach by Transit Party No. 1, a party of 5 men with canoes left Prince Albert to contour both banks in the stretch of river surveyed. Contours at intervals of four feet were taken, beginning about 2 miles above the first rapid of the Series and ending at "The Forks", 15 miles below. The length of the several rapids and fall in each was ascertained, the low stage of water being favourable for this work.

Owing to the lateness of the season, the contouring of the Cadotte, Nipawin, Tobin and Squaw Rapids surveyed by Transit Party No. 2, could not be undertaken in 1910. The Party was therefore called in and paid off at Prince Albert on October 8th.

"La Colle Falls". The first serious obstacle to navigation in the Saskatchewan River below Prince Albert consists of a series of 14 short rapids having a total fall of 88 feet in 13 miles of River. The fall in the rapids proper amounts to 50 feet, the remaining 38 feet being taken up in intervening "swifts". A list of these Rapids follows:-

No.	Name	Lgth.	Fall	No.	Name	Lgth.	Fall
1.	Peace Rapid	1/8 M.	1.5 ft.	8	No Name	3/8 M.	2.3 ft.
2.	Big Stone	1/4 M	3.7 "	9	" "	1/4 "	4.1 "
3.	Squaw Rapid	1/4 "	1.4 "	10	Horseshoe R.	3/8"	2.4 "
4.	Demicharge	3/8 "	3.4 "	11	Stony R.	1/4 "	5.4 "
5.	No Name	1/8 "	1.0 "	12	Crooked R.	7/8 "	7.5 "
6.	" "	1/8 "	1.7 "	13	No Name	5/8 "	4.8 "
7.	Steep Creek R.	5/8 "	6.7 "	14	" "	3/8 "	3.9 "

The River bed here is considerably restricted, varying in width from 400 feet to 800 feet at low water. It is confined between steep clay and gravel banks rising in places 200 feet above river level. Low flat lands, with cut banks 10 to 20 feet high, extend a considerable distance back from either side of the river, the opposite shore rising either side of the river, the opposite

shore rising abruptly to prairie level.

A number of sharp turns or "bends" occur in this section. In several of these bends, large boulders, carried by moving ice from the higher reaches of the river, have accumulated and cover practically the entire bed. Most of the rapids of the series are found in these bends.

The current in the "La Colle Falls" reach flows with an average speed of about 4 miles an hour at low water, increasing at the crest of rapids to a maximum velocity of 8 to 10 miles an hour, where steep pitches are encountered. Owing to these swift waters and the presence of boulders, many of which are barely submerged at ordinary level, navigation of this reach is most difficult and hazardous at all times. It is practically impossible for steamboats or large craft of any description to ascend the rapids, except at high water, and in order to do so they are compelled to "line" or "warp" over several steep pitches, a slow and wearisome process, even when winches or capstans are available. At low water row boats and canoes overcome these rapids by "tracking", and usually take two days time to cover the 13 miles stretch above the Forks.

The permanent improvement of this reach for navigation can only be accomplished by means of locks and dams. The first five rapids - The Peace, Big Stone, Squaw, Demi Charge and Rapids No. 5 - will be rendered navigable upon the completion of the City of Prince Albert's Hydro-Electric Power Development works below the Demie Charge Rapids, work on which however, was entirely suspended August 29th, 1913, and has not since been resumed. The remaining rapids of the series can be made navigable by the construction of a dam with canal and locks at The Forks.

Sketch plans of the City of Prince Albert's works mentioned above, and of proposed works at The Forks, are

shown on plates C-1 and C-2 attached and forming part of this report. (See Pages 69 and 70.)

Wing Dams, of cribwork and stone construction, rising from 4 to 5 feet above low water, have been suggested as a possible means of improving the La Colle Falls reach. It is doubtful whether their use would prove effective in maintaining the desired channel depth when low water stages obtain. As such dams must restrict the channel materially in order to raise the water surface, the velocity of the stream will of necessity be increased, thereby causing dangerous cross-currents and eddies near these structures; moreover as the dams will be submerged at high water, their presence will be a menace to navigation, being but a few feet below the surface, and invisible owing to the muddy waters when the river is in flood. Further, driftwood, of which an enormous quantity is carried down the river annually by the spring and summer freshets, being held by these dams as the water falls, will be liable to anchor and jam when released, and block the channel completely. In view of these objections, Wing Dams are not proposed in the above named reach.

Cadotte Rapids. The Cadotte Rapids are met with 98 miles below Prince Albert. The river at this point is from 1200 to 1400 feet wide, and falls 4.7 feet in about 7/8ths of a mile. One mile above the Rapid, cut banks of clay and sand, 60 feet in heights, line the North Shore.

Further down the river, both banks become rugged and irregular, rising to a height of 130 feet at the foot of the Rapids.

No difficulty is experienced by large craft in navigating the Cadotte Rapids at high water, as during that period there is a depth of 16 to 18 feet of water in the Channel. At low water, however, navigation is possible for small boats only, two feet being the average depth.

The removal of boulders and dredging of a channel

8000 feet long through the boulder ridge will render the rapids navigable.

Nipawin Rapids. These rapids begin about 3 miles below the Cadotte Rapids and extend 3 - 1/8 miles down stream, the fall in this distance being 15.3 feet.

The river, for two miles above, and one mile below, follows a sinuous course, making five sharp "Bends", in which the swift waters are encountered. A good channel, from 6 to 8 feet deep at low water is found here, except in a few places where the depth varies from 2 to 4 feet only. Its general direction is parallel to the steep clay banks, from 175 to 200 feet high, which alternate on either side of the river at the several bends. A current running from 4 to 5 miles an hour at ordinary stages, increases to a velocity of over 8 miles an hour when the river is in flood. The range between high and low water in the Nipawin may be generally taken at 15 feet.

As in the case of the Cadotte Rapids, the Nipawin series offer no serious obstacle to navigation, the swift waters being the main difficulty to contend with. They can be made safely navigable at low water for craft of less than 5 feet draught, by dredging shallow spots and removing boulders where these have been deposited in the channel.

Tobin & Squaw Rapids. The Tobin Rapids occur 156 3/4 miles below Prince Albert, where the river broadens out into a shallow bed covered with large boulders, 2 3/4 miles long and from 1000 to 1800 feet wide. They are followed 1½ miles further down by the Squaw Rapids, the intervening stretch being deep and swift but free from boulders. There is very good water in the Squaw Rapids, of which there are two pitches, but a large number of heavy boulders make them difficult to navigate. These Rapids are the last in the Saskatchewan River between Prince Albert and Le Pas.

The fall in the Tobin is 19.8 feet, whilst in the

Squaw Rapids, 1¼ miles long, there is a fall of 6.8 feet. For three miles below the Squaw Rapid, the river falls rapidly, the current running about 6 miles an hour. These rapid waters are called "Swifts", to distinguish them from the Rapids immediately above, i.e., where the pitches occur, although they may, properly speaking, be considered as part or continuation of the rapids. The total fall from the head of the Tobin to the foot of these swifts, amounts to 45.7 feet in a distance of 8½ miles. Naturally, the improvement of the two Rapids should be considered together.

Navigation, when the river is low, is not possible in the Tobin Rapids, for boats of any description. For two miles above, the river is very shallow, there being less than 2 feet of water in places. An average depth of two feet is maintained in the rapids. Boulders are so numerous that the river was crossed on foot by stepping from stone to stone in the late summer of 1911.

For the improvement of the Tobin and Squaw Rapids, a dam with three locks of even lift is proposed at the foot of the second pitch in the Squaw Rapids, as shown on sketch plan C-3 attached and forming part of this report.

With the contour information thus far secured, it may be stated that the water at this site can be raised some 68 feet without damaging an excessive amount of valuable timber, or flooding adjacent farm lands, the surrounding country being still unsettled. The new level established would render the river navigable as far as the Nipawin Rapids, or about 47 miles above the dam, thereby dispensing with a very large amount of dredging required in this reach, apart from providing considerable storage for power development purposes.

Sturgeon River "Cut Off". The Saskatchewan at Mosquito Point, 178 miles below Prince Albert, broke through its banks about 40 years ago when in flood, causing the main

body of water to flow into Cumberland Lake by way of the Sturgeon or Torch River. Before discharging at the western extremity of the Lake it divides into numerous small channels, of which the "Steamboat Channel" and the "Angling Channel" are the main routes followed in reaching Cumberland House, 55 miles below the Cut Off via the "Old"or Little Saskatchewan River. (See plate D.)

Owing to the reduced flow in the Little Saskatchewan due to new conditions created by this diversion, the river has silted rapidly and is now quite shallow, sand bars extending almost from shore to shore at several points. Navigation is not possible here at low water except for row boats or canoes. The channel, however, is followed by steamboats and tugs at high water, when the increased flow provides sufficient depth for such boats.

The diversion of the main river into its former channel at the Cut Off will be necessary in order to permanently improve this section of the River. The type of work intended for that purpose is shown on plate "F". (See page 61)

The improved route via the Little Saskatchewan will always be possible for steamboats, whilst the present one, via the Sturgeon River will eventually have to be abandoned owing to shallow water in Cumberland Lake, where the many channels enter. The Lake acts as a settling basin, in which an enormous amount of alluvial matter carried by the Saskatchewan is deposited. As a result of this process, the western end of Cumberland Lake is silting rapidly and, in a number of years, will become too shallow for navigation of any kind.

It is expected that the proposed diversion works at the Cut Off will remedy this condition and that, by increasing the flow in the "Old" channel, now shallow and constricted, a good channel will scour itself out in a few years, between the Cut Off and the mouth of the Big Stone River, 53 miles

below, without any considerable amount of dredging.

Saskatchewan below Big Stone River. The Big Stone River is one of the two main outlets of Cumberland Lake, joining the Saskatchewan where this river resumes its former character, i.e., at the end of the Little Saskatchewan River. From this point to Le Pas the Saskatchewan broadens considerably and is easily navigable at all stages.

The preliminary examination made in 1910, has disclosed the fact, since confirmed by soundings taken the following year, that a satisfactory channel, not less than 150 feet wide and from one to two fathoms deep, extends all the way from the Big Stone outlet to Le Pas, and that consequently over this stretch of 70 miles, no dredging whatever is necessary.

Office Work. Upon the completion of field work in October, two Assistants were retained for office work, headquarters of the survey being established at Edmonton shortly afterwards.

The checking of levels, calculating and adjustment of traverses for platting by latitudes and departures, etc., were attended to. Diagrams of temperatures and precipitations in the mountain regions were prepared from information supplied by the Meteorological Stations at Banff and Edmonton. Water gaugings were platted and a preliminary profile of the water surface determined between Edmonton and Le Pas. Generally, the co-ordination and study of information collected in 1910 occupied the office staff during the winter months or until surveys were resumed in the spring of 1911.

Season 1911

Organization. Three parties were put in the field in 1911:- A Transit and Sounding Party of 20 men, a Levelling party of 6 men, and an hydraulic or Metering party of 2 men. Extra men were hired for the last named party at metering stations. The new survey boat, with a crew of 8 men, was also employed, making a total of 36 men engaged on the Survey.

The staff of Assistants, Rodmen, Chainmen, Recorders, etc. numbering 13, were assigned to their respective parties upon reporting at Prince Albert and Edmonton during the latter part of May. The main party was outfitted at Prince Albert, whilst the Levelling and Metering parties made Edmonton their starting point.

Survey Boat. A new petroleum boat, the "Lafleur", especially designed for river survey work, was built at Edmonton in the early spring, and commissioned in June, being later brought down river to Prince Albert, for service during the season.

The "Lafleur" is of the flat-bottom, stern-wheeler type, 63 feet long, 14 feet beam and drawing less than 2 feet of water aft, when running. It is driven by one "Meitz & Weiss", 2 cylinder, 450 revolutions per minute,marine oil engine (Diezel type) developing 30 horsepower at mormal speed. Transmission is by opinion and bevel gears to countershaft connected by chain to sprocket, reducing in that manner the revolutions of the paddle wheel to 36 per minute. The speed of the boat is about 10 miles an hour.

A small pile driver hammer can readily be mounted on deck for driving stakes or piles used for supporting water gauges.

Gauges. The new survey boat was employed in setting up intermediate water gauges at the following points:—

Locality	Mile	Locality	Mile	Locality	Mile
Ft. Saskatchewan	25	Pakan	76	Desjarlais Ferry	103
Hopkin's Ferry	158 3/4	Vermillion R.	194 3/4	Ft. a la Corne	555½
Nipawin Rapids	595	The Cut Off	671	Pemican Portage	725½

Gauges were also established at Rocky Mountain House, near the confluence of the Clearwater River with the Saskatchewan, and in the South Saskatchewan River at Saskatoon, for use in connection with discharge measurements of these rivers, on which work the Hydraulic party was engaged.

A complete list of water gauges in use during the progress of the survey from 1910 to 1915, is given in Table VIII, Appendix E. Page -

Daily readings, of gauges set the preceding season, and of gauges at above points were taken until November, when ice formed.

Driftwood and logs, carried by the summer flood, were responsible for the loss of several gauges in the upper river, shortly after they were put in position. They could not be replaced in 1911, the survey boat being detained down river until October, when it was laid up for winter at Prince Albert.

Traversing and Sounding. The transit and sounding party was engaged throughout the season on the survey and sounding of the reach from Prince Albert to Le Pas, 308 miles in length, the work lasting from June 1st to September 15th.

A stadia traverse was made of this reach, the method being considered sufficiently accurate to define the river course generally, and to locate sounding ranges, since connections or ties were possible at convenient intervals with existing surveys of Dominion Lands. These were effected about every four or five miles, where section or township posts were accessible. Discrepancies in distances, due to stadia work, were adjusted by latitudes and departures, so as to conform to Township surveys, when notes were being platted.

A detailed survey, with contours at 4 foot intervals of the country, in the vicinity of Sturgeon River "Cut Off" was also made. The survey extends about 2 miles along the Saskatchewan and a short distance only on the "Little Saskatchewan" and Sturgeon Rivers. It will afford the desired information for the study and design of proposed diversion works at that point.

Method employed. The method of cross reading from shore to shore, alternately between two transits, was made the basis of the stadia survey. Each transit swept only the opposite shore for traverse stations and location of range stakes. Magnetic readings of main courses were taken. With the checks thus obtained on both angles and distances, the maximum error of the stadia work was found to be 1 in 200 and usually much less.

Wherever possible, transit stations were selected above ordinary high water so as to insure their permanence, and enable the survey to be re-traced, if necessary. Stations were marked in the usual manner by hubs with copper or tinned nails driven in the centre; each was referenced by measurements to nearby trees and further marked with cross-head. Hubs were numbered to accord with stakes set for sounding ranges, not by the sum of the stadia courses, as usually done.

Soundings were taken about 50 feet apart, on parallel ranges 500 feet distant perpendicular to the current. In places where this was not possible, as in Rapids or where the river was both wide and swift, soundings were taken on "diagonal ranges" or lines traced by the sounding boat when landing and starting from the same point, to land again on the opposite shore further down stream. This method may not be commended, but combined with the use of a prismatic.

compass, it can be successfully employed for sounding considerable stretches of river accurately surveyed but otherwise not staked.

Where a more exact delineation of the river channel or bottom was desired, parallel ranges, 200 feet distant were sounded. The first two miles from Prince Albert were sounded at close range, as also some two miles in the vicinity of the Sturgeon River "Cut Off", where the special survey mentioned above was made.

Only in the "Little"or "Old" Saskatchewan River - a stretch of 53 miles - was it possible to conduct soundings by canoe; elsewhere, a 34 foot lumberman's boat or "pointer" was employed. The sounding force consisted of a sounder, recorder, steersman, one or two signalmen, and 6 oarsmen. The boat was equipped for 8 oarsmen, but with adequate rests, 6 men could keep good "line" in a current of from 3 to 6 miles an hour, where the river was 1000 feet wide and over, and when crossing the Rapids.

Ranges were staked ahead of the sounding boat by two rodmen with canoes, after they had become somewhat expert in estimating distances. Stakes were located by two transits, one on each shore, angles and distances being recorded as the stadia traverse was carried on.

An interval of time equivalent to four beats of the oars was allowed between soundings, this being found to give, in full stream, soundings about 50 feet apart. A constant rate of speed on any one range was maintained as much as possible, thus dispensing with the actual location of soundings by transit.

Owing to starting the boat with "head up", there is a tendency for too many soundings on the starting side, which, when platted, will draw the bottom contours out a little from that side. Where the channel lies close to the bank the irregularity of contour lines may be quite noticeable,

but, inasmuch as this fault will prevent the laying out on the charts of a channel too close to the bank, the error is unimportant. The return lines likewise show the utmost prominence of shallow water on the opposite shore. Fifty (50) feet, however, may be regarded as the limit of error for any sounding on the line.

In platting the soundings, deductions were made for the total length of a line, for bars outlined by the stadia, or paced across by the sounder, when such bars were submerged.

Soundings thus secured in a river varying from 1000 to 2000 feet in width will, when platted to a scale of 500 feet to an inch, permit the tracing of contours defining the 6 foot depths with sufficient accuracy to base an estimate of the cost of developing a channel 6 feet deep and at least 150 feet wide wherever dredging is found necessary.

In view of the frequent channel changes to which the Saskatchewan is subject, any refined delineation of contours would have meant a useless waste of time, involving considerable additional expense, not warranted at present, and of little value after the probable lapse of several years before work is commenced.

During the season 1911, the transit division occasionally worked as a separate party some days in advance of the sounders.

The average rate of progress made was 3 miles per day; under normal conditions the sounding crew immediately followed the transit force.

Levelling. The levelling party was occupied during 1911 connecting up levels of the four sections incompleted the previous year. The start was made from Edonton in June, 3 canoes being used for transport, and Le Pas reached September 27th.

One hundred and forty-two (142) miles of levels were run between sections, and 12 miles of the 1910 levels on section 2 re-run, forming a total of 154 miles for the season.

The continuous line of levels from Edmonton to Le Pas, 801 miles long, is marked by 302 benches at intervals of 2 to 4 miles. Bench marks could not be established permanently for obvious reasons; except where destroyed by falling banks, however, it is expected they will remain in good condition for a number of years. A complete list of bench marks from Edmonton to Lake Winnipeg, with distances and locations, is given in Appendix "E", Table 1, page

<u>Hydraulic Party</u>. Discharge measurements of the North Saskatchewan River at Edmonton, Battleford, Prince Albert, The Forks, and Le Pas were made in 1911. In addition, the South Saskatchewan was metered at Saskatoon. The Forks, the Clearwater River, near Rocky Mountain House, and the Carrot and Pas Rivers in the lower Saskatchewan.

Two series of meterings were taken at each of the above places. Results of these measurements are given in Table IX Appendix "E", page

The method in common use, of measuring the velocity of the current and the area of cross-section of stream, was followed in determining discharges.

Two Price Current Meters were used: - one large meter, W. & L.E. Gurley pattern No. 600 for measurements in the Saskatchewan, and one small meter, pattern No. 621, indicating only every fifth revolution, for use in small streams in the Mountains. Both meters were rated at the Calgary rating station of the Irrigation Branch of the Dept. of the Interior.

<u>Office Work</u>. The staff was engaged during the winter months in the computation and adjustment of the traverse from Prince Albert to Le Pas, the checking of levels and adjusting of same

to datum adopted, the reduction of soundings, preparation of profiles, diagrams, etc.

The platting of office plans was started and work well advanced when the survey was resumed the following spring. These plans are drawn to a scale of 500 feet to an inch on sheets of uniform size 3' x 10'. No less than 71 such sheets were required for the platting, on the scale adopted, of the 941 miles of river surveyed from 1910 to 1915.

Season 1912

Field Parties. Early in the summer of 1912, three field parties were organized for the season's surveys: A party of 19 men for traversing and sounding, a party of 11 men for special surveys and contour work, and a third party of 6 men for metering in the foothills. The two river parties were organized at Edmonton, whilst the hydraulic party assembled at Rocky Mountain House, which place was used as a base during the season. In addition, the Survey boat "Lafleur", with a crew of seven men was commissioned, thus forming a total force of forty-four men employed in 1912.

Transit and Sounding Party. This party was detailed to traverse and sound the Saskatchewan from Edmonton towards Prince Albert. The Survey was started at the C.P.R. High Level Bridge during the latter part of May, and was brought to a close about 2 3/4 miles below Lashburn Ferry on August 21st.

During the three months work was carried on, 226½ miles of river were traversed by stadia, and 250 miles sounded on parallel ranges 400 feet apart, except in the nine rapids of this reach, where sounding ranges were staked 200 feet distant, in order to secure a closer definition of the channel. All islands were traversed and their positions fixed, when necessary, by triangulation from main stations on the shore traverse.

Temporary gauges were set up at each camp and read daily at proper intervals, the records being used with those furnished by main gauging stations at Edmonton and Battleford, in establishing the low water plane for the reduction of soundings.

Transit and Contour Party. Special detailed surveys of short sections of river in which nine of the principal rapids below Edmonton occur, were made by the above named party. Twenty three and one half (23½) miles were traversed and forty-nine and one half miles (49½) miles contoured. Levels were carried from the nearest bench mark to the head and foot of rapids and the fall in each, ascertained. Names of these rapids with distances from Edmonton, follow:-

Mile	Name	Lgth. Miles	Fall	Mile	Name	Lgth Miles	Fall
52½	Sucker Rap's (series)	6¼	20'	166½	Wolf Pond R.	1¼	8.0'
77½	Victoria "	1 3/4	8'	173½	Moose Rap.No.1	3/8	2.0'
105	Crooked "	½	4'	177 1/8	" " No.2	3/8	2.5'
133½	Eye "	3/8	3.5'	186 3/4	Frog Rap.	3	5.2'
163	Dog Rump " (series)	2¼	9.5'				

In addition to the above list, six smaller rapids from 1/8th mile to 1¼ miles long, complete the series of 15 rapids below Edmonton. The Frog Rapids, of which there are two pitches are the last to be met with, ending 6 miles above the mouth of the Vermillion River. From this point islands and shifting sand bars predominate throughout the reach to Prince Albert.

A list of all Rapids in the Saskatchewan River from Edmonton to Lake Winnipeg will be found in the Appendix "E" Table VI. page

There are no steep pitches in any of the rapids surveyed the greatest fall being four (4) feet in one half mile, in the Crooked Rapids; these being most difficult to navigate on account of the swift waters and sharp turns in the Channel. Fairly good water is found in the Sucker, Victoria, and

Frog Rapids, but numerous large boulders in the channel render them unsafe except at high water, whilst the Eye, Dog Rump, Wolf Pond, and Moose Rapids, are very shallow and unnavigable at low stages.

Locks and dams are not proposed for the improvement of any of the above named Rapids; the removal of boulders and dredging of shallow spots will afford the necessary channel depth to render them safely navigable at all stages.

Hydraulic Party. Discharge measurements of the North Saskatchewan and Clearwater Rivers at Rocky Mountain House, and of the Brazeau, Nordegg and Baptiste Rivers, were made in 1912, the information being required in connection with the study of flood control and regulation begun the preceding year.

Owing to loss of time due to unfavourable weather - rain having fallen almost incessantly during the summer months - and to the difficulty of travel between Rocky Mountain House and the region of the Baptiste and Brazeau Rivers, it was not possible to secure more than two meterings of each of these streams during the season. These are given in Table IX. Appendix "E" page -

Sites for storage dams were found and examined by the Hydraulic Party on the Saskatchewan River below Rocky Mountain House, and on the Brazeau River, a few miles above its confluence with the Saskatchewan. Both these rivers flow in places through steep sandstone banks from 200 to 300 feet high, affording suitable locations for the building of such dams.

Possible dam sites on the Saskatchewan, and on several of its tributaries at headwaters, a number of which were examined or surveyed in 1912 and subsequent years, are shown on Plate G.

Gauges. New gauges were placed by the survey boat for sounding purposes at Pakan, Duvernay and Vermillion River, gauges at these points having been carried away by floods in 1911. Intermediate gauging stations were also established at Ceepee (The Elbow) and Carlton Ferry in the Battleford-Prince Albert reach.

Permanent gauges for use in connection with meterings were set by the Hydraulic party in the Saskatchewan River at Rocky Mountain House, and in the Clearwater River about 2 miles from its mouth.

Records of daily gauge readings at fixed stations along the river from Rocky Mountain House to Le Pas were kept, as in previous years, until late in the season.

Office Work. The calculating of field notes, adjustment of levels, reduction of soundings, etc., and platting of office plans, profiles, diagrams, etc., occupied the attention of the office staff during the winter months.

Season 1913

Field Party. A combined transit and sounding party consisting of 28 men was organized at Battleford on the 15th of May to carry on the survey of that section of the River between Mile 250, or 2 3/4 miles below Lashburn Ferry, where work was discontinued in 1912 and Prince Albert.

The party was equipped with two "pointers" and eight canoes, and conveyed by the survey boat to a point 78 miles above Battleford, where work commenced.

The survey was carried on continuously during the summer months; 243 miles of river having been covered by the time Prince Albert was reached on the 15th of August. After effecting a connection with the Prince Albert - Le Pas survey made in 1911, the party was reorganized, part of the men being paid off, the remainder proceeding by train to Le Pas, where the survey of the Lower Saskatchewan River was resumed.

Method Employed. The method of "cross river" sighting for traversing by stadia, and of estimating distances for the staking of sounding ranges, used in 1912 on the survey of the upper part of the river, was found efficient and advantageous, as after travelling 250 miles, the estimated distances by pacing or by boat, had only exceeded the true distance by less than five miles. Work in 1913 was therefore carried on under this system the only change made being that four transits were used instead of two. It was found advantageous to use the two extra transits to enable the party to define more rapidly the large number of sand bars and islands predominating, especially in the Battleford district, and to maintain sounding ranges staked in advance of the sounders. By working double parties of two transitmen each, it was possible to survey the two channels formed by an island or sand bar simultaneously, thereby saving valuable time necessarily lost in paddling up river, which would have been lost if the channels had been surveyed independently.

Lashburn Ferry to Prince Albert. The river between Lashburn Ferry and Prince Albert assumes the character of a typical prairie stream; no rapids are involved for this section, the fall throughout being uniform and averaging 9/10th of a foot per mile. It is generally wide and shallow and full of sand bars and islands. The width varies from 1000 to 1200 feet in its narrowest part, to 4600 feet, or over three quarters of a mile in the vicinity of Battleford. Although there are frequent short stretches from 10 to 12 feet deep at low water, the average depth is less than 6 feet. The bottom is mostly sand and soft material overlaying clay and hard pan. Gravel is occasionally met with. Banks rise from 100 to 200 feet above the river to the level of the prairie, which in places is quite distant from the water, forming a wide valley, mostly wooded with poplar and occasional clumps of spruce. The wooded banks become more plentiful in the lower part of the reach.

The tributaries, with the exception of the Battle River, are small, the principal ones being Turtle River, Jack Fish Creek, and Shell Brook, flowing from the north and Eagle Hill Creek, discharging from the south near The Elbow.

Improvements. A large amount of dredging and the building of extensive dykes to divert and confine the flow into the dredged channel, will be required to render this section of the river navigable. Maintenance charges will be heavy on account of the shifting sand which is continually wearing away in some places and filling in at others. This action is very rapid at certain stages, one case being observed where a width of 10 feet was washed away from the side of a sand bar within 10 hours, this particular bar being from 2 to 5 feet above the surface of the water. Hubs that were set immediately before the extreme high water in July 1912, were found to be covered with as much as 9 inches of silt after the flood subsided.

It is expected that by means of low dykes, disposed at an angle with the current, in places where bars can form behind such works, the silting of the navigable channel will to a large extent, be prevented, thereby reducing maintenance charges accordingly.

Locations of proposed dykes throughout the river are shown on Charts accompanying this report. A typical section of same appears on Plate F. attached (See opposite page 61.)

Bridges and Ferries. The country between Lashburn Ferry and Prince Albert is well settled, the main line of the Canadian Northern Railway running parallel to the river from Paynton to Langham, or for a distance of 117 miles, and being within six miles of the river at any point along this reach.

Two high level railway bridges, with navigation spans, cross the river, one about 7 miles above Battleford, and the other at Ceepee ("The Elbow"). Both of these bridges are on the main line of the Canadian Northern Railway. A combined highway and railway bridge on a branch line of the same

railway, with swinging draw span to accomodate navigation, also crosses the river at Prince Albert; and two high level highway bridges over the north and south channels respectively at Battleford, afford direct communication between that town and North Battleford.

Several scow ferries, established by the Provincial Government, provide crossings of the river on main roads of travel and to the roadway. A list of Ferries on the North Saskatchewan River will be found in Appendix "E" Table XII, p.

<u>Survey from Le Pas - East</u>. On the arrival of the boats and equipment, which were shipped by rail from Prince Albert after the reorganization of the party in August, the survey of the portion of the river between Le Pas and Lake Winnipeg was begun. The party consisted of 15 men.

As the country east of Le Pas was not subdivided, a different system had to be used for the survey of the Lower Saskatchewan River. The method previously followed of a stadia survey, with frequent ties to township or section corners of Dominion Lands Surveys was abandoned, and in substitution a system of secondary triangulation adopted. This was considered essential for the accurate mapping of the 140 mile stretch to Lake Winnipeg, as in this distance ties with the 13th and 14th base lines of Dominion Lands Surveys were possible only at a few points where these lines intersect the river and the shores of Cedar Lake. A base, from which the triangulation was extended, was measured on the Hudson's Bay Railway Bridge at Le Pas, and connected with the survey completed to that place in 1911.

Levels were carried along by the party as the triangulation progressed, bench mark being set approximately at intervals of one mile. Soundings were taken, as previously, on parallel ranges, 500 feet apart, range stakes being set with transit and stadia.

The survey was suspended for the season on the 7th of October, 29 miles of river having been triangulated, traversed,

levelled and sounded below Le Pas. The party was brought up river by the Ross Navigation Company and disbanded the following day.

It may be mentioned here that navigation between Le Pas and Cedar Lake was closed on the 18th October, heavy ice having formed in the reach on that date. This is believed to be the earliest recorded freeze up of the Saskatchewan River.

A list of dates on which the ice in the North Saskatchewan River went out at Prince Albert, each year from 1878 to 1916, and of dates on which the river froze over from 1899 to 1916, is given in Table XI., Appendix "E". The list was compiled from actual records made at the time by Messrs. R. Gwynne and T.E. Parker of Prince Albert.

Description. The river for the first 29 miles below Le Pas varies from 700 feet to 1800 feet in width, and from 8 feet to 25 feet in depth, the least depth being ample for navigation purposes. The current at low water is very slow, running less than 2 miles an hour, the average fall in the river being only 2/10 of a foot per mile.

Eighteen miles below Le Pas, Moose Lake or Summerberry River is met with. This is but another name for one of the two principal Channels into which the Saskatchewan River divides at this point. After leaving the main channel, the Summerberry River flows in an easterly direction towards Moose Lake, and discharges partly into that lake through a small stream called Moose Lake Creek. At Moose Lake Creek, it makes a sharp turn and follows a southerly course for about 20 miles, dividing once more into two channels, the first channel flowing south westerly until it meets the Saskatchewan 6 miles above Cedar Lake Post (Chemahawin), the other continuing in a south easterly direction towards the North Arm of Cedar Lake into which it discharges.

The banks, which are about 25 feet high at Le Pas, gradually become lower further down river, and at that point where the survey ended, were no more than 3 or 4 feet above

the water level. These banks are thickly wooded with poplar for several miles below Le Pas where the poplars cease and are replaced by a fringe of willows only a few hundred feet wide on each shore. The whole tract of the country along this reach is flat and almost entirely under water, being covered by a succession of broad shallow lakes and sloughs, filling through numerous channels and "Cut Offs", when the river is in flood.

Mountain Party. A party of 5 men, with 7 pack horses, left Rocky Mountain House on the 8th of July, to investigate the storage possibilities on the head waters of the North Saskatchewan River, and its principal tributaries in the foothills, for flood control purposes. The party was engaged on this work until the early fall when it returned to Rocky Mountain House and was disbanded on the 19th of September.

Three possible dam sites were examined on the Clearwater River, two of which, however, were found to be of insufficient storage capacity and abandoned. The location of the site selected is approximately in Townships 34 and 35, Ranges 10 and 11, west of the 5th Meridian, in a gap of the Brazeau Mountains, about 55 miles from Rocky Mountain House, and is shown on Plate G-1 attached. A cross section of the valley on centre line of dam and contour line at elevation selected for crest of dam, appear on plan. The dotted contour line on west end of plan is approximate only. It was not considered advisable to continue the survey further up the river, inasmuch as the valley narrows to such an extent that no appreciable storage would be provided.

The site is an excellent one and will afford a storage capacity of 214,500 acre-feet with a dam 144 feet in height. The flooded area in round numbers is 3,131 acres, and the fall of the river approximately 27 feet per mile.

At each end of the proposed dam is a mountain of solid rock and loose rock; ample building timber is found in the neighborhood. The valley is of a gravel nature, all material

for construction purposes being available on the spot. Under such conditions a dam, though expensive, could be economically built to the height stated.

Owing to lack of time, no borings were made to ascertain the depth at which a suitable foundation for such a dam could be found, but there is no reason to doubt however that solid rock foundation is accessible within a very few feet from the surface.

The watershed of the Clearwater dam site is approximately 473 square miles.

An advantageous site for a dam was also found in a gap between two mountains on the Saskatchewan River at Kootenay Plains, about 75 miles up river from Rocky Mountain House. This is also shown on Plate C-1. The location is approximately in Township 39, Ranges 14 and 15, west of the 5th Meridian, and probably this is the most suitable site on that River. It is only 7 miles by trail from the Railway at Mire Creek. Gravel and sand may be obtained from the river bed adjoining the site; jack pine and spruce grow on the flats above, while rock may be had in unlimited quantities from the mountains on either side of the gap. Conditions therefore are in every way favourable for economical construction at this point.

It is possible to create a reservoir at "The Gap" by means of a dam having a crest elevation 175 feet above ordinary level with a spillway 1000 feet or more wide. Such a reservoir would provide a storage of 300,000 acre-feet. An area of about 4,290 acres would be flooded by this dam.

The watershed at "The Gap" is approximately 1,761 square miles and the fall in the river about 11 feet to the mile.

It is not proposed to construct dams of the heights mentioned on either the Clearwater or Saskatchewan Rivers, as the cost of such structures would be prohibitive. The control and regulation of flood waters can probably be effected

by means of dams not exceeding one hundred feet in height, providing a sufficient number of sites are available at headwaters.

Sites surveyed in 1913 and subsequent years with drainage area of proposed reservoirs are shown on Plate G. attached. Possible dam sites remaining unsurveyed, and metering sections occupied in 1914 and 1915, are also shown on this Plate.

Gauges. Records of the daily readings of water gauges at the following main sections were kept in 1913: - Edmonton, Battleford, The Elbow (Ceepee), Prince Albert and Le Pas.

The gauge established in the upper part of the river, near Rocky Mountain House, at the mouth of the Clearwater River, was read at noon daily throughout the season.

Office Work. The office staff at Prince Albert was engaged during the winter months in reducing soundings, calculating triangulation, adjusting stadia traverse, levels, etc., for platting on office plans. Work on these was well in hand when the survey was resumed in 1914.

Season 1914

Field Parties. Three survey parties were put in the field in 1914: - a Transit, Level and Sounding party of 25 men, to continue the survey of the river east of Le Pas towards Lake Winnipeg; a Contour party of 6 men, to define the limits of flooded areas in the event of locks and dams being used for the improvement of the Cadotte, Nipawin and Tobin Rapids below Prince Albert, and an Hydraulic Party of 6 men to secure discharge measurements of the Saskatchewan River and its tributaries in the mountains, and to investigate possible sites for dams and storage reservoirs in connection with a project for flood control and regulation.

Transit, Level and Sounding Party. The party was assembled at Le Pas on the 12th of May, proceeding a few days later with boats and canoes to a point 20 miles down

River where the season's work was commenced.

The triangulation of the main channel, which was discontinued at this point in 1913, was carried forward for a distance of 46 miles to the entrance of the Saskatchewan into Cedar Lake, the system being tied to the 14th base line of the Dominion Lands Surveys where this line crosses the river.

From the end of the triangulation, a traverse survey of the south shore of Cedar Lake was made and continued easterly for a distance of 61 miles, or as far as Napanee Bay, where work was stopped in 1914. The west shore of Collin's Island, and all of the Rabbit Point on the north shore of the lake were also traversed, the distance covered being 15 miles. A total of 76 miles of shore traverse and 46 miles of river triangulation was made during the season.

Stadia surveys were also made of the principal channels into which the river divides below Le Pas, the smaller ones, not usually navigated except by canoes, being neglected.

Two parallel lines of levels were run along the river for the full length of the south shore traverse; Bench Marks being established as before at intervals of approximately one mile. A connection was made with the levels run over the 14th base line by the Topographical Surveys Branch, Department of the Interior.

Soundings were taken of all river channels covered by triangulation and stadia surveys, ranges being approximately 500 feet apart and disposed at right angles to the stream.

Cedar Lake was sounded 3 miles out from the entrance of the Saskatchewan River, where a minimum depth of 10 to 12 feet of water was found.

It was considered unnecessary to extend soundings further into the lake, as the depth increases uniformally in the direction of Rabbit Point, averaging from 30 to 35 feet on the navigation course followed in the wide part of the lake. Soundings were resumed in the neighborhood of

Rabbit Point, where shoal waters are again met with. About 2 miles of lake east of Collin's Island and Rabbit Point were sounded on ranges 500 feet distant before the party was called in.

The season between the middle of May and the middle of July, while the party was located at Cedar Lake, was very favourable for survey work, only 1½ days being lost in two months time on account of rain. The river was also low during the summer, thus permitting of rapid progress being made.

The wind was responsible for some loss of time during the latter part of the season. Considerable difficulty was experienced, especially during the last two weeks, in taking soundings, owing to the smoky condition of the atmosphere, caused by forest fires along the east end of the lake.

The early Fall, in 1914, was unusually mild, there being practically no frost up to the time the field work ended on October 8th.

The party was brought back to Le Pas by the Ross Navigation Company's S.S. "Brisbane", arriving on the 15th of October, after being "wind Bound" three days at High Portage, and further delayed at the entrance to Cedar Lake, and at the first bend of the Saskatchewan above Chemehawin, where the "Brisbane" ran aground. The party was paid off and dispersed the following day.

Method of Traversing. A double set of chainmen and two transitmen were used in running the traverse from the east end of Cedar Lake to Lake Winnipeg. Each course was chained over independently by the two sets of chainmen, the first set carrying a continuous chainage with a 100 foot chain from the starting point, the second set following with a 66 foot chain, the distances in this case being measured from station to station only.

Angles were read by the principal transitmen in two positions of the horizontal circle, the second position

being approximately 90 degrees different from the first; as both verniers were reach each time, this gave four readings for each angle, the mean of which was adopted. Angles were repeated or doubled by the second transitman, the values thus obtained being used as a check only. In case of any serious discrepancy, the work was re-checked.

Shore lines and topographical details generally, were filled in by the stadia.

Connections. The traverse on the north shore of Cedar Lake from Rabbit Point, easterly, was connected by triangulation to points fixed on Collin's Island by triangulation from the south shore traverse. A tie was made with the 13th Base line where this line crosses at the western end of the Lake, and another where it cuts through Rabbit Point, about 18½ miles further east.

Description. Between the point where the survey started in 1914 and Cedar Lake Post (Chemahawin), a distance of 46 miles, the river follows a sinuous course in a south-easterly direction, through a low flat country filled with lakes and sloughs. It varies in width from 200 to 1400 feet, the depth running anywhere from 6 feet to 28 feet, with the exception of the last 6 or 7 miles above Chemahawin, where the channel is partly blocked with sand and mud, and a few shallow spots further up river, where there is less than two feet of water at low stages.

The fall in the river between Le Pas and Cedar Lake is very small, averaging only 2/10ths of a foot per mile.

The banks in the upper part of this reach are from 3 to 4 feet high but gradually become lower further down. At the "Frying Pan" - 62 miles from Le Pas - a ridge of rock ending on the south shore of the river and rising about 10 feet from the water, marks the last high point above Chemahawin. Below the "Frying Pan" the banks are less than a foot above summer level, and are entirely covered when the

river is in flood except possibly at "Brown Rock" where the bank is somewhat higher. The banks are wooded with small poplar and willow, the poplar disappearing 12 miles above Cedar Lake. This bush forms a narrow strip or fringe a few hundred feet wide on both shores; beyond lie meadows or sloughs and large shallow lakes which in places cover the surrounding country for miles in all directions.

The first rock was observed on the east shore, opposite Medecine Tent Point, about 22 miles below Le Pas. It consisted of limestone in ledge formation, and outcropped at the "Frying Pan" and at intervals between this point and Cedar Lake.

The principal islands in the main channel are known as Ross Island, 22 miles below Le Pas; Hill Islands, a group of islands 3½ miles long, 12 miles further down; and the two Kettle Islands, which are met with at Mile 60 from Le Pas.

Immediately below Poplar Point, the river divides into three channels flowing to the south; one of these is very wide and shallow and expands into what is known as Mud Lake. About 4 miles above Chemahawin, the river again divides at "Brown Rock", one small channel flowing north-easterly into the North Arm of Cedar Lake, the other from 200 to 350 feet wide, following a southerly course until it meets with the waters of Mud Lake, one mile above Chemahawin. Swallow Creek is a very narrow channel connecting the first mentioned channel, ½ mile east of Brown Rock, with the main river opposite Chemahawin.

At Chemahawin, and for two miles down, the river varies from 800 to 1000 feet in width and 10 to 25 feet in depth. Further down it rapidly widens and becomes very shallow - from 1 to 5 feet deep - as it flows through marshy lands before discharging into the lake.

A sand and mud flat, covered with 3 to 4 feet of water extends from the end of the deep channel as far as the

entrance into the lake - between Duncan's Island and Oleson's Point - or for a distance of over 4000 feet. The depth in the lake increases gradually from this point, being 12 feet three miles out where soundings were discontinued, and over 35 feet in its deepest part, east of Rabbit Point.

Considerable dredging will be required to secure the desired channel depth where the river enters Cedar Lake. The depth in the upper reach, surveyed in 1914, is sufficient for navigation purposes, with the exception of the 5 or 6 miles immediately above Chemahawin, where a small amount of dredging will be required; and of the small rapids at Poplar Point and the Frying Pan, where shoals and boulders, with less than two feet of water in its low stages, extend partly across the river.

The country is not suitable for settlement along this section of the river, except at Pine Point, about 52 miles below Le Pas, where a winter trading post is located; and near Cedar Lake, where Cedar Lake Post, established by the Hudson's Bay Company in the early days, has developed into the Indian Village of "Chemahawin". The land everywhere else is too wet and marshy for cultivation and is completely flooded at high water stages of the river.

Cedar Lake is about 36 miles long and from 15 to 20 miles wide in the main part. It is separated from Lake Winnipegosis to the south by a strip of land from 4 to 6 miles wide, being about 10 feet high at the waters edge, and rising farther back to 90 feet near Lake Winnipegosis. A good team portage, known as "High Portage", crosses this strip at its narrowest point, about mid-way between the east and west shores of Cedar Lake. Mossy Portage, used by canoes only, affords communication between the two lakes west of High Portage.

The bays on the south side of Cedar Lake are mostly shallow with rock bottom; shores are generally of rock from 10 to 15 feet high, covered in low spots with sand, marsh,

and muskeg patches; they are wooded with spruce, poplar, and scrub of no value except for fuel. Small quantities of amber are found on the beach in a bay about 7 miles from Chemahawin; pieces are smooth and of irregular shape, the larger ones being about 3/4 of an inch long. It is more plentiful after a storm from the eastward, being washed up from the bottom of the lake.

Cedar Lake and Lake Winnipegosis have practically the same elevation.

A project to lower the level of Cedar Lake about 11 or 12 feet, by enlarging the outlet into Cross Lake, would, in the event of proving feasible, afford drainage to lands adjacent to the Saskatchewan River, from the Sipanock Channel to Cross Lake, thereby reclaiming a very large tract of country for agricultural purposes. Particulars of this investigation may be found in the report of Mr.T.H.Dunn, C.E., published in the Annual Report of the Superintendent of Water Powers, Department of the Interior, for the year 1913-14.

Contour Party. Surveys of the river below Prince Albert, having in view the possible improvement of the Cadotte-Nipawin series of Rapids, and of the Tobin and Squaw Rapids, by means of locks and dams, were made by the above party during the latter part of the season.

During the eight weeks the party was engaged on this work contours at 8 feet intervals were carried over a distance of 11 miles of river in the first named series of rapids, and over an equal distance in the Tobin-Squaw rapids.

Two possible dam sites were located; the first at Mile 599½ or immediately below the last rapid in the Nipawin series, where the water may be raised some 63 feet, thereby drowning out these rapids, and the Cadotte Rapids further up river; the second site being at the foot of the Squaw Rapids (Mile 655) where favourable conditions exist for raising the water 68 feet above present level, providing in that manner

uninterrupted navigation to the foot of the Nipawin Rapids, 47 miles above.

The development of a large amount of hydro-electric power is feasible in connection with such improvements, though owing to river distance from possible markets - Le Pas and the City of Saskatoon being about 100 and 200 miles distant respectively, and no other considerable markets more readily accessible are likely to exist for a number of years to come - as power projects alone they would be over-expensive and unadvisable at the present time.

Hydraulic Party. This party was organized at Rocky Mountain House during the latter part of June, and was engaged until the fall in securing discharge measurements of the principal streams in the Saskatchewan watershed west of Edmonton. A pack train of 10 horses served for transportation of outfit, instruments, supplies, etc.

Meterings of the Clearwater and Saskatchewan rivers near Rocky Mountain House were made, after which the party proceeded to the Brazeau District. The Brazeau, Nordegg and Baptiste rivers were metered, these streams being also examined several miles from their mouth for possible sites for dams and storage reservoirs.

The party returned to Rocky Mountain House the first week in August, and after metering the Clearwater and Saskatchewan rivers, left for the headwaters of the Saskatchewan, establishing metering sections on the larger tributaries as far as the mouth of the Siffleur River before starting on the return trip.

The Clearwater and Saskatchewan rivers were again metered after the return of the party to Rocky Mountain House, the second week in October, after which the party was disbanded.

Discharge measurements secured in 1914 are given in Appendix "E" - page 213.

Gauges. Daily readings of water gauges were received at the following stations during the season:-

1. - Rocky Mountain House, Alta.
2. - Edmonton, Alta.
3. - Battleford, Sask.
4. - Prince Albert, Sask.
5. - Le Pas, Man.
6. - Chemahawin (Cedar Lake) Man.

The water was at a very low stage in the Saskatchewan in 1914. Gauge readings secured in the late fall served to fix the low water plane in the section of river between Le Pas and Cedar Lake.

Survey Boat. It was not considered necessary to put the launch "Lafleur" in commission this year, as when needed, tugs of the Ross Navigation Co. of Le Pas were available for visiting and supplying the field party at work below Le Pas.

The launch, however, served as a supply and house boat later in the season, when the survey of Cedar Lake was under way. She was brought down from Le Pas and anchored in one of the sheltered bays on the south shore of Cedar Lake, being towed from bay to bay, keeping in that manner within easy reach of survey camps. She was brought back to Le Pas in the fall and pulled out on shore where she was laid up for the winter.

Office Work. During the winter months the staff was employed in working up the notes of the season's labours in the field. A very large amount of calculations was required in connection with the triangulation and chain traverse before notes could be platted.

Pantagraph reductions of 58 office sheets, covering the survey of the river from Edmonton to Le Pas, were made. Reduced charts to a scale of 2000 feet to one inch, with profiles, showing present channel and proposed improvements by dredging, were under preparation but will require several months more work before they can be in condition to be photo-lithographed for publication.

Season 1915

Field Party. A combined transit, level and sounding party of 18 men was organized at Le Pas early in June, for the survey of the eastern portion of Cedar Lake and of the reach of the Lower Saskatchewan River, from Cedar Lake to Lake Winnipeg.

On June 10th, 1915, the party, accompanied by the survey boat "Lafleur", left Le Pas for Cedar Lake reaching Rabbit Point, where camp was established, late at night the following day.

A stadia survey was made of the north shore of the lake from Rabbit Point, and continued on the north shore of the river below the Flying Post Rapids, whilst the chain traverse of the south shore was taken up where it was discontinued in 1914, and carried forward to the western end of the Hudson's Bay Co's tramway at the head of the Grand Rapids. It was considered unnecessary to extend the survey beyond this point, as the remaining section of river to Lake Winnipeg had been surveyed by the Manitoba Hydrographic Survey in 1912. After connecting the traverse and levels with those of the above named survey, work was brought to a close on October 9th, 1915, and the party brought back to Le Pas where it was dismissed.

Traversing. About 30 miles of chained traverse were run during the season. Points on the north shore of Cedar Lake, from 2 to 4 miles apart, were fixed by triangulation from the south shore traverse. These served to check the stadia work. The north shore and all islands were traversed by stadia; this work being connected by triangulation to the chained traverse. Two large bays at the eastern end of Cedar Lake and the north and south bays in Cross Lake were triangulated across instead of carrying the traverse around the shore; this saved considerable time and insured the completion of the survey that season.

Levelling. The double line of levels were carried along the south shore, jointly with the chain traverse, as in previous years. Bench Marks were established approximately one mile apart. Levels were carried across O-nah-hap-e-win Bay by sighting from island to island, none of the sights being over 1/8 mile long; the method of reciprocal sights was used in this case, and also in the carrying of levels across a number of smaller bays.

Levels were carried over Cross Lake by water transfer, gauge readings being taken for several days on both sides of the lake. A check on this work was obtained by connecting with Bench Marks on the 13th Base Line on the east and west sides of the lake.

Soundings. All of the eastern part of Cedar Lake was sounded with the exception of the channel south of Collin's Island, O-nah-hap-e-win Bay and the bottom of the large bay at the extreme northeast end of the lake. Soundings were taken every 100 feet on parallel ranges about 1000 feet apart. Twelve lines, 1000 feet apart, were sounded between the east and west shores of Cross Lake in the vicinity of the Saskatchewan River.

The river was sounded from Cedar Lake to the head of Grand Rapids, ranges in this reach being set closer together, or about 500 feet distant, except in rapids, where it was found necessary to run the sounding lines down the river instead of across.

Method of Sounding. A sounding rod was used for depths up to 16 feet; for greater depths a 6 pound sounding lead with line was used. The crew of the sounding boat consisted of one sounder, one recorder, six oarsmen and steersman. Two canoes, with two men each, were used for moving beacons and two transitmen, occupying stations on shore, located the position of soundings by intersections on flag in the sounding boat. The boat ran from north beacon to south beacon on one

line, returning in the opposite direction on the next line. Only every fifth sounding was located by intersections, a red flag being used instead of the white flag to designate such soundings. The number of line sounded, colour of flag, and time of reading on flags, were noted by the recorder and the two transitmen on shore.

Some of the sounding lines were four miles in length, but under favourable weather conditions, little difficulty was experienced in seeing the flags or in keeping the sounding boat in the line of beacons.

Rabbit Point to the Narrows. At Rabbit Point, Cedar Lake narrows considerably, being only about 6 miles wide opposite that point. Further on, the lake maintains a fairly uniform width of from 2½ to 3 miles to its eastern extremity. A good channel from 15 to 20 feet deep was found from Rabbit Point to the Narrows. The bottom is rock everywhere.

The shores in this reach are mostly of limestone in ledge formation, and vary in height from a few feet to twenty feet in places above the water. Where the rock disappears the shores become low and marshy.

Many islands are found in this part of the lake. In general they are low at the south west end, whilst the northeast end is rocky and from 8 to 12 feet high. A thick growth of spruce and poplar covers most of the islands.

Two large bays extend several miles inland from the main shores:- O-nah-hap-e-win Bay on the south shore, west of the Narrows, and a bay - not named - on the north shore at the eastern end of the lake.

It may be mentioned here that O-nah-hap-e-win Bay is improperly named Napanee Bay on official maps. It is known to the inhabitants of Grand Rapids Settlement by the Cree word meaning "the Bay or place where you can see all around".

The Narrows to Cross Lake. The "Narrows" are met with at the eastern end of Cedar Lake. The name is given to a small

channel between Moose Island and the south shore, about 100 feet wide and 6 to 7 feet deep at its entrance, through which part of the waters of Cedar Lake flow swiftly into the Saskatchewan. 200 feet below the entrance, the channel widens, gradually becoming very shallow. At the foot of the Island less than three feet of water is found at low stages.

Another channel exists between Moose Island and Sugar Island to the north east. It is considerably wider than the Narrows and fairly deep part of the way, but it is seldom used by navigators as it shallows rapidly at its lower end, and is considered unsafe except at high water.

The north east or left shore of the river below the Narrows is generally low, being mostly flooded over during high water, whilst the opposite shore is low in places only, high rocky banks prevailing to Cross Lake. There are a number of large bays in this stretch and a few small lakes a short distance back from the river.

The Flying Post Rapids occur three quarters of a mile east of the Narrows. The river here turns due south, and divides at the head of a large island into two channels, flowing very swiftly over a bed of solid rock for 5/8ths of a mile. The fall of the rapid in this distance is 2.8 feet. Very little water is found in either channel at low stages. The greatest depth being in the western channel, but even here in places it is not more than two feet deep.

Below the rapids, and for 3 miles down, the river is quite wide and from 7 to 10 feet deep. In this stretch, when a heavy south wind is blowing against the current, the water becomes rougher than in the rapids.

A shoal having 3 to 4 feet of water over it, extends from Centre Island to the West shore for one half mile above Anchor Point. The small rapids opposite this point, having a fall of 2.2 feet in one quarter of a mile, are caused by this shoal.

From Anchor Point to the Demie Charge Rapids, a distance of three quarters of a mile, the river is from 6 to 9 feet deep in the channel and one half mile wide. At the Demie Charge it flows over a rock ridge, dividing into three channels before discharging into Cross Lake.

The water is very swift in the main rapids between Spruce and Calico Islands, the fall being 4 feet in a distance of three eighths of a mile. At low stages, there is not more than 3 or 4 feet of water in the rapids. They are not navigable for steamboats except at high water.

For the improvement of the reach from Cedar Lake to Cross Lake, a dam above the Demie Charge Rapids with lock and canal, as shown on sketch plan C-4, is proposed (See opp. p. 73). The new level established by this dam will afford a 10 foot channel for lake navigation as far up as Le Pas, without materially increasing the dredging necessary for a 6 foot channel, should it be considered advisable to maintain Cedar Lake at its present level.

Cross Lake to Grand Rapids. From the Demie Charge Rapids to the eastern shore of Cross Lake, where the Saskatchewan resumes its course towards Lake Winnipeg, the distance is about 6 miles. Deep water from 15 to 30 feet, was found in the belt, two miles wide, sounded across this part of the Lake.

Leaving Cross Lake, the river expands into a large bay (Portage Bay) to the north, dividing a half mile further down into three channels formed by two islands. The Cross Lake Rapids occur at this point. The main channel in these rapids flows along the south shore of the river, and is over 1200 feet wide, and from 2 to 4 feet deep, whilst the two smaller channels average less than 300 feet in width, and are quite shallow. The fall in the main channel is 3.3 feet in a distance of 7/8ths of a mile.

At ordinary stages, no difficulty is experienced in navigating the Cross Lake Rapids. To render them safely navigable at low water, the deepening of the channel through the limestone ridge, causing these rapids, will be necessary.

The Red Rock Rapids follow one mile below the Cross Lake Rapids, the intervening stretch of river being about 1200 feet in width and from 10 to 20 feet in depth. The rapids are one mile long and have a fall of 12.7 feet in that distance. The river bed is solid rock everywhere, strewn with large boulders.

Banks of clay, 5 to 10 feet high on the north shore but quite low and rocky on the opposite side of the river. The rock from which the rapid derives its name outcrops about midway in the rapids on the south shore, and rises 10 feet above the water.

Good water, from 8 to 10 feet deep, is found at the head of the rapids, and also in the channel which follows the north shore for a half mile below the head of the rapids; this depth decreases further down to 3 or 4 feet and is maintained to within a short distance of the foot of the rapids.

Navigation is difficult and hazardous in the Red Rock Rapids owing to the very strong current and rocky shoals. It is proposed to improve this reach by means of locks and canalization as shown on sketch plan C-5 (See opp. p. 75).

A good channel exists from the Red Rock to the Grand Rapids, 4 miles below. The river in this reach varies in width from 800 to 1200 feet and is from 10 to 15 feet deep everywhere, (except immediately below the Red Rock Rapids, where the depth is from 6 to 8 feet for about one half mile). The current runs very swiftly in this portion of river. The banks gradually become higher on the way down, reaching a height of 45 to 50 feet in the Grand Rapids. They are for the most part of white clay, but in several places limestone ledges appear.

The small tramway, formerly used by the Hudson's Bay Company for portaging over the Grand Rapids, ends about half mile from the head of the Rapids. The distances from this point, along the tramway, is about 3½ miles to Grand Rapids Settlement at the mouth of the Saskatchewan.

The Grand Rapids offer the greatest obstacle to navigation of any of the rapids in the Saskatchewan River below Edmonton. They fall 70 feet in less than 4 miles, the rough and swift waters flowing over a solid bed of rock strewn with boulders which show above the water in many places.

The two heaviest pitches occur at the head of the rapids. The first pitch which is about 1100 feet long, is followed, a third of a mile below, by another pitch, 800 feet long, the gradient in both being 40 feet to the mile. Further down the slope decreases appreciably, being fairly uniform for 3 miles to the foot of the rapids, which point is about two and one half miles from Lake Winnipeg. The Upper half of the rapid is from 8 to 10 feet deep, the limestone banks in this portion of the river rising thirty feet high in places. The stream bed narrows from 1300 feet where the rapids begin to 500 feet below a small island, where the river does not exceed 800 feet in width, but becomes quite wide further down, being no less than 2400 feet from shore to shore at the foot of the rapids. The banks in the lower half of the rapids are of white clay overlaying the rock, and rise from50 to 60 feet above the water. From 2 to 5 feet of water is the average depth in this reach.

The improvements proposed at Grand Rapids in the interests of navigation, consist of a dam with a series of four locks and canal, the general arrangement of which is shown on sketch plan C-6, (See opposite page 78.)

<u>Hydraulic Party</u>. The Survey of possible dam sites and storage reservoirs on the North Saskatchewan River and

tributaries at head waters, in connection with the regulation and control of flood waters, on which progress was made in 1912 and 1914, was continued during the season under review.

A party of seven men, consisting of an Hydraulic Engineer, two recorders, two axemen, one packer, and one cook, with 10 pack horses, left Rocky Mountain House on July 7th for the Baptiste River, arriving at the mouth of that river three days later.

A metering of the Baptiste was made, after which the survey of the dam site and reservoir 3 miles from the mouth of the river, was started. This work lasted until the first week in August.

The site selected is within 14 miles of the nearest wagon road and 32 miles from the railroad. The stream at this point is 145 feet wide and averages 5 feet in depth. The bed is gravel over clay, but rock probably extends under the clay at no very great depth, as it rises to the top of the bank on the south shore. Banks above the dam site are of clay with a covering of loam.

Conditions are favourable for the construction of a dam, about 90 feet in height, at this site. The length of such a dam at crest elevation 185, as shown on plate G-2 would be 1270 feet. The reservoir thus formed would provide 41,202 acre-feet of storage. At elevation 160, the capacity of the reservoir would be 19,017 acre-feet. Gravel and sand are available for construction purposes along the river, whilst timber - jackpine and spruce are plentiful on the side hills.

The party left the Baptiste River on August 9th for the Brazeau, reaching that river on the 13th after cutting several miles of new trail. The survey of the Brazeau Dam site occupied the party until September 11th. Results of this survey follow:--

Location of dam site:-	Brazeau River, 1400 feet below the mouth of the Nordegg River,
Width of Stream:-	420 feet.
Average depth of stream:	3.6 feet.
Stream bed:-	Gravel and boulders over clay changing to rock.
North Bank:-	Clay and loose rock between river and steep rock cut bank.
South Bank:-	Loose rock at foot of steep rock cut bank.

Elevation of crest of dam:-	200 feet
Elevation of Water Surface:-	100 "
Height of dam above water:-	100 "
Length of dam at crest:-	721 "
Storage to elevation 200:-	44,704 acre-feet
" " " 180:-	26,212 " "
" " " 160:-	12,950 " "

Gravel and sand are found at the mouth of the Nordegg River, while jackpine and spruce grow to large sizes on the side hills and flats; these are readily accessible for construction purposes. Solid rock most probably exists a few feet beneath the river bed, and, if there, will afford a stable foundation for a dam of the maximum height.

The dam site on the Brazeau River is about 65 miles from Rocky Mountain House by the present trail which is travelled by pack trains only. As in the case of works on the Baptiste River, materials and supplies for works on the Brazeau can be hauled from Rocky Mountain House over the river ice during the winter at less expense than either by land or water in the summer months.

Plate G-3 attached shows the Brazeau-Nordegg reservoir surveyed in 1915.

The survey of a dam site and reservoir at Glacier Lake

in the mountains, was made in the latter part of the season, Glacier Lake being reached on October 5th. After completing this work, the party left on October 20th for Rocky Mountain House, arriving on November 2nd. Men were paid off the following day. The following are the results of this survey:-

Location of dam site:-	On Glacier River, 1600 feet from the foot of Glacier Lake.
Width of stream:-	165.0 feet.
Depth of stream:-	Two or three inches only, (nearly dry at this season.)
Stream bed:-	Sand, gravel, boulders and rock.
Left Bank:-	Clay, loam gravelly soil over hardpan and rock.

Elevation of crest of dam:-	157.0 feet
Elevation of water surface:-	83.0 "
Height of dam above water:-	74.0 "
Length of dam at crest:-	617.0 "
Storage to elevation 157:-	54,477 acre-feet.

Gravel and sand for concrete work can be found at the head of Glacier Lake and where Glacier River empties into the Middle Fork. At several points along the river rock cut banks exist, while jackpine and spruce may be obtained in sizes up to 20 inches in diameter.

Glacier Lake is about 80 miles by trail from Nordegg, a mining town on the Canadian Northern Railway. The location of Glacier Lake reservoir is shown on Plate G. A cross section at the site of dam with area of reservoir, etc., appear on plate G-3.

Meterings of the Baptiste, Brazeau and Nordegg Rivers, and of Glacier Creek at the outlet of the Lake, were made during the season while surveying reservoir sites in the vicinity. Discharges, etc., are given in Appendix "E" Page

In addition to the sites on the Clearwater and Saskatchewan Rivers located in 1913, and on the Baptiste, Brazeau and Glacier Rivers in 1915, a number of favourable locations for dam and reservoirs are known to exist on the North Ram and South Ram Rivers, Wapiti River, South Branch of the Brazeau River, Brazeau Lake, and on the Saskatchewan River below Windy Point. These are shown on Plate G., as also are sites at Mistaya, Pyramid, Lower Waterfowl and Peyto Lakes on the Mistaya River, a preliminary survey of which was made by the Irrigation Branch of the Dept. of the Interior in 1915.

Further surveys will be required in order to determine the storage capacity of reservoirs at the above named points. When these surveys have been completed, the possibility of regulating the flow of the Saskatchewan River below Edmonton may be definitely ascertained.

Gauges. Daily readings of water gauges were taken at Edmonton, Prince Albert, Le Pas, and Chemahawin during the season 1915. Hourly readings of gauges at Edmonton and Prince Albert were taken during the flood of June-July, at which time the water rose to a height slightly above the record flood of August 1899. The maximum discharge of the Saskatchewan on July 2nd, 1915, when the crest of the flood passed Prince Albert, is estimated to have been no less than 200,000 second feet.

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S A S K A T C H E W A N R I V E R

A N D

B A S I N

Saskatchewan River and Basin.

General. The North and South Branches of the Saskatchewan River rise at high elevation on the eastern slope of the Rocky Mountains in South Western Alberta, the many streams contributing to their flow being fed by the melting snows and glaciers of the Mountain regions.

The North Branch, after leaving the foothills and receiving the waters of the Clearwater, Brazeau and other minor tributaries west of Edmonton, and of the Battle River in the prairie districts, flows in an easterly direction through the great plains of Central Alberta and Saskatchewan, uniting about 840 miles from its source with the South Branch at "The Forks". From this point it is known as the Saskatchewan River. Flowing through Cumberland, Cedar and Cross Lakes, on its course towards Lake Winnipeg, the Saskatchewan discharges its waters into Lake Winnipeg at the foot of the Grand Rapids some 410 miles below "The Forks".

The total length of the Saskatchewan, from headwaters of the North Branch to Lake Winnipeg, is approximately 1,250 miles. The river, as its name implies (Cree:- Swift or Rapid Current) is rapid flowing, the total fall in the 941 miles surveyed from Edmonton to Lake Winnipeg, amounting to 1292.6 feet, or an average fall of 1.37 feet per mile. Plate B. attached, shows a profile of the river at low water stages.

A table showing the fall of the river per mile in the various reaches, is given in Appendix "E" page

Drainage Basin. The area of the Saskatchewan River drainage basin, as computed from latest official maps, is approximately 156,000 square miles. The territory comprising this basin, extends from the eastern slope of the Rocky Mountains for about 750 miles in an easterly direction to

Lake Winnipeg, and some 400 miles northerly from the International Boundary, the greater part of Southern Alberta and of Central Saskatchewan lying within the limits of this area. The basin of the Saskatchewan is shown on Plate "E" attached.

Conditions in the North Saskatchewan River Watershed are described in Appendix No. 4 of the "Report of Hydrometric Surveys (Stream Measurements) for 1915", published by the Irrigation Branch, Dept. of the Interior Canada, as follows:- ..."The basin naturally divides itself into five parts, - The first or upper part consists of the eastern slope of the Rocky Mountains. While this part of the basin is not the largest in area, the greater part of the run-off is derived from it. In glaciers and perpetual snows of the higher peaks innumerable small streams rise and flow eastward, forming large streams which empty into the main river. These streams are also fed by the melting of heavy snows and by rains which fall in the mountains at all seasons of the year. The region, being mountainous has a tendency under these conditions to discharge a great quantity of water into the streams in a short time. This is seen each spring, as the mountains, being for the most part bare of vegetation, are exposed to the sun which melts the winter's snow in a short time. If this warm weather is accompanied by rain, floods take place. The lower parts of the mountains and the valleys have a good forest cover and they alone dampen the effects of warm weather. The streams in this part have a slope of from 20 to 500 feet per mile.

"Below the mountain division are the foothills or second part of the basin. This is the largest area of the five parts. Here the river heads north easterly and is joined by a great many rivers of various sizes. The valley of the river becomes better defined and deeper. The country is hilly and rough but is not as broken as the first part. The

whole region has a fairly heavy precipitation and is well covered with forest. Large tracts of muskeg are found in this region and while to a certain extent they have a tendency to make the run-off uniform if they become well saturated, they offer less resistance than bare hillsides to rapid run-off of heavy rains. The slope of the river in this section is probably from five to twenty feet per mile.

"From near Edmonton to the mouth of the Vermillion River, the North Saskatchewan River flows through a park-like country with large stretches of prairie. Few tributaries flow into the flats along the river. The slope of this section averages 1½ feet per mile.

"The fourth section, from the Vermillion River to Prince Albert, is principally prairie with a few stretches of small timber and second growth. The valley of the river is much wider and the river itself widens out into shallow reaches full of shifting sand bars. Low-lying flats border the river for the greater part of the course. The slope of this section is less than a foot per mile.

"The fifth and last division is from Prince Albert to "The Forks" or junction with the South Saskatchewan. This section has a slope of 1½ feet per mile, made up of a series of rapids. The valley is not as deep as in the two previous sections, and the river channel is better defined. The basin is covered with a fair tree growth with very little prairies land."

Below "The Forks", the river spreads out in broad, swift stretches, with several rapids and many sand bars. The banks are of clay and from 20 to 250 feet high, being cut almost vertically in places. Alluvial flats alternate with the high banks in the first 100 miles. The country further down falls rapidly and becomes flat and marshy, the whole region from the Squaw Rapids to Lake Winnipeg being low lying and filled with lakes and muskegs.

Fairly large timber - spruce, jackpine, birch and poplar - suitable for construction purposes, is found along the banks and on the larger islands in the Saskatchewan, above the Sturgeon River "Cut Off". The lower basin, generally, is lightly wooded, the growth being confined to a narrow strip in the edges of the rivers and lakes.

Floods. Like all mountain streams, the Saskatchewan is subject to great fluctuation in flow, due to the characteristic conditions prevailing in the upper reaches. Two distinct floods take place each year: the first, usually in April or early May, is of short duration, and in evidence when the freshets from the foothills and western plains come down and carry the ice out of the river. It may be noted that the South Branch of the Saskatchewan River breaks up first in the Spring, usually from 8 to 10 days before the North Branch is clear of ice. The second, known as the summer flood, generally occurs in the latter part of June, high water prevailing during July and the first weeks in August. This last flood, when in full force, is by far the heavier and more destructive of the two; to it is attributed the rapid erosion of the banks and constant changing of the channel bed which are characteristic of the river.

Diagrams on plates A-1, A-2, show the heights of the summer floods at various stations where records were kept from 1910 to 1915.

During the period from August to March, the river gradually decreases in volume, the three winter months of January, February and March being the period of lowest water on account of the frozen condition of the whole drainage basin.

The minimum winter flow at Edmonton may safely be taken at 1,000 cubic feet per second for computing the power producing ability of the river. A maximum discharge of 207,447 c.f.s., was recorded on June 28th, 1915, when the

crest of the worst flood in 50 years passed Edmonton. The Edmonton gauge on that day showed a height of 44.5 feet above low water.

Navigation. The Saskatchewan River is considered to be a navigable stream throughout its length from Rocky Mountain House, west of Edmonton, to Lake Winnipeg, notwithstanding the many rapids distributed along its course.

In the early days of the Hudson's Bay Company, canoes were used for freighting from York Factory, on Hudson's Bay to the Company's posts in the interior, the highway of travel being via the Nelson River, Lake Winnipeg and the Saskatchewan.

In 1825, at a Council meeting held at Norway House and presided by Sir George Simpson, Governor of the Company, a resolution was passed authorizing the building of York Boats for freighting; these were in common use until the advent of steamboat navigation in the late seventies.

In subsequent years, and until 1910, steamboats were operated by the Company from the head of the Grand Rapids as far up as Edmonton, the custom being to make one or two round trips a year for the purpose of carrying supplies for the posts.

Railroad transportation, however, gradually superseded river traffic in the North West, and in the fall of 1919, the "Saskatchewan", the last of the Company's steamboats navigating between Le Pas and Prince Albert, was laid up at Le Pas, where it has since been dismantled.

The steamboats in use by the Company were stern wheelers from 100 to 130 feet long over all, and drawing a maximum of 3 feet. By towing two barges, from 90 to 125 tons of freight could be carried each trip.

Several boats owned by Transportation Companies and private parties were also navigating both Branches of the

Saskatchewan River prior to 1910. Two of these boats, the "Northwest" and "Marquis", were 200 feet in length. (See list of Steamers on the Saskatchewan River, Appendix "E" Table XIII.)

Navigation usually opened about the end of May or the first days in June, in the high water period, and continued until the water fell to low level, late in August, and occasionally until the end of September. The long summer days permitted of almost continuous trips being made, the boats tying up only for two or three hours during the night. Return trips from Le Pas to Edmonton (1,600 miles) were frequently made in less than two weeks time under favourable conditions.

At the present time, commercial navigation on the Saskatchewan is confined to the upper reaches in the Edmonton District, and to the lower river, between Cumberland Lake and "The Narrows" in Cedar Lake. Two steamboats - one of which is over 300 gross tonnage - are engaged in passenger and freight traffic at Edmonton, whilst a fleet of steam tugs with barges, and several motor boats, ply on the lower river and northern lakes, making Le Pas their home port.
At Prince Albert, steamboat navigation has practically ceased since 1914, the only boat on the river being used for lumbering purposes in connection with the sawmill at that place.

Traffic. Before the advent of railway communication in the west, traffic on the Saskatchewan River consisted principally in the hauling of supplies of the Hudson's Bay Company and other traders to posts and settlements established along the river up to the head of navigation at Edmonton.

Transportation via the Saskatchewan has steadily decreased during the last thirty years owing to the greater facilities offered by the railways, and at the present time

may be said to have entirely ceased, except on the upper river, where steamboats still navigate for about one hundred miles below Edmonton, and on the lower Saskatchewan in the Cumberland, Le Pas and Cedar Lake Districts.

Water communication if re-established on the Saskatchewan, is expected to develop an important traffic in coal, minerals, lumber, grain, livestock and farm produce, traffic of this nature being principally derived from the adjoining country. The new route will also facilitate the exchange of products and supplies between the settlements along the river and in the interior and the principal centres at Edmonton, Battleford, Prince Albert and Le Pas. Grain and other commodities loaded on barges and river boats at points on the Saskatchewan, will be hauled by water to Le Pas, and shipped on to the Hudson's Bay Railway from that place to Port Nelson, when destined to European ports, or transferred to lake steamers at Le Pas and shipped through to Winnipeg. The traffic westward will consist principally in manufactured products, farm implements, machinery, etc., and generally in such classes of heavy freight as can be more readily and economically transported by water than by rail.

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IMPROVEMENTS

AND

ESTIMATES

Improvements and Estimates

Character of Improvements. The establishment of a navigable waterway for light draught vessels on the Saskatchewan River, from Edmonton to Lake Winnipeg, in accordance with the project herewith submitted, will necessitate the carrying out of the following works:

(1) The deepening of the present channel in places, by dredging, and the removal of boulders in rapids;

(2) The building of diversion and bank protection work in reaches where sand bars predominate; and

(3) The construction of locks, dams and canals at points where rapids cannot be made navigable otherwise.

Dredging.

Quantities and cost. A total of 19,183,374 cubic yards of material will require to be removed from the river bed, by dredging, to secure the desired depth and width of channel from Edmonton to Lake Winnipeg. The estimated cost of this work amounts to $4,839,597.00, representing an average cost of about $5,143.00 per mile for the 941 miles of river to be made navigable.

Plates 1 to 59 show, in red colour, the sections of the channel to be dredged. The estimated quantities, with area of cut and classification of material, are given in Table VII, Appendix "E", for each mile of river, where dredging is required. A summary of the total cost of dredging the eight reaches into which the river is divided for this work, appears on the following page.

Channel width and depth. For the requirements of shallow draught navigation that is likely to develop between

NORTH SASKATCHEWAN

DREDGING

REACH	LENGTH MILES	MATERIAL	QUANTITIES CU. YARDS
Edmonton	77	Boulders and Rocks,	106,900
to		Stones, Gravel & Clay	3,267,150
Pakan		Mud and sand	23,200
Pakan to	118	Boulders & Rocks	104,850
Vermillion		Stones, gravel & clay	2,620,600
River		Mud & Sand	431,850
Vermillion River	134	Boulders & Rocks	450
to		Stones, gravel & clay	726,100
Battleford		Mud & Sand	4,037,050
Battleford	164	Boulders & Rocks	10,200
to		Stones & gravel & clay	727,300
Prince Albert		Mud & Sand	2,383,350
Prince Albert	178	Boulders & Rocks	127,552
to		Stones, Gravel & Clay	797,419
Cut Off		Mud & Sand	502,473
(Sturgeon River)			
CUT OFF	130	Mud & Sand	2,855,150
to			
Le Pas			
Le Pas	79	Solid Rock	46,900
to		Stones & Clay	145,400
Cedar Lake		Mud & Sand	18,200
(Duncan Island)			
Cedar Lake	61	Solid Rock	250,280
to		Stones, Gravel & Clay	1,000
Lake Winnipeg			

Total cost of dredging, Edmonton to Prince Albert.......

" " " " Prince Albert to Le Pas ....

" " " " 6 ft. channel from Edmonton to Le Pas.............

Dredging Le Pas to Lake Winnipeg - 10 ft channel ....

Total cost Dredging, Edmonton to Lake Winnipeg..........

Distance Edmonton to Lake Winnipeg.....................

Average cost Dredging per mile ....

RIVER SURVEY

SUMMARY

) Edmonton to Le Pas 150 ft. wide, 6 ft. deep
Channel(
) Le Pas to Lake Winnipeg, 150 ft. wide, 10 ft. deep

PRICE	COST	REMARKS
$1.25	133,625.00	Pointe-aux-Pins, Vermillion & Sucker Rapids
.30	980,145.00	in this reach - Average cost per reach:-
.10	2,320.00	$14,500 per mile
Total	$1,116,090.00	
$1.25	131,062.50	Eight series of rapids in this reach.
.30	786,180.00	Average cost for reach:-
.10	43,185.00	$8,140 per mile
Total	$ 960,427.50	
$1.25	562.50	No rapids in this reach - Average cost for
.30	217,830.00	reach: $4,640 per mile.
.10	403,705.00	
Total	$ 622,097.50	
$1.25	12,750.00	No rapids in this reach - Average cost for
.30	218,190.00	reach:- $2,860 per mile.
.10	238,335.00	
Total	$ 469,275.00	
$1.25	159,440.00	La Colle Falls, Cadotte, Nipawin, Tobin & Squaw
.30	239,225.70	Rapids in this reach - Average cost for reach:-
.10	50,247.30	$2,522 per mile.
Total	$ 448,913.00	
.10	$ 285,515.00	Dredging at Cut Off to divert River into Old Bend and 50% of estimated quantities for Old Saskatchewan - Average cost per mile $2,200.
$3.00	140,700.00	For 10 ft. navigation from Le Pas to Lake
.30	43,620.00	Winnipeg. Average cost per mile:- $2,360.
.10	1,820.00	
Total	$ 186,140.00	
$3.00	750,840.00	Channel Canal & Lock Excavations at Demie
.30	300.00	Charge, Red Rock & Grand Rapids are given on
Total	$ 751,140.00	separate sheets. Average cost per mile:- $12,300.
.....	$3,167,889.00	about $6,425 per mile
.....	734,428.00	" 2,385 " "
.....	$3,902,317.00	
.....	937,280.00	
.....	$4,839,597.00	
About	$ 5,143.00	

Edmonton and Le Pas, following the completion of the proposed waterway, a channel 150 feet in width and 6 feet deep at low water is sufficient and has been provided for in the estimate. For the remaining reach to Lake Winnipeg, the estimate is based on a channel of equal width but 10 feet deep.

The proposed waterway above Le Pas will accomodate steamboats of the stern wheeler type, 200 feet long, and drawing from 3 to 4 feet of water when loaded, the channel width provided allowing ample room for the passage of boats travelling in opposite directions. Below Le Pas, a 10 foot depth of channel will permit lake vessels to navigate Cedar and Cross Lakes at all times, flat bottom boats and barges being unsafe on these waters during stormy weather.

Material. The material to be dredged consists chiefly of mud, clay, sand and gravel; and can be most economically disposed of by the use of self-propelling combination dipper and hydraulic dredges especially designed for this class of work. For the removal of rocks and boulders in the rapids, clamshell or orange peel dredges will be required.

The percentage of the different materials to be removed by dredging, as classified in Table VII, follows:-

Mud and sand.............	53.4%
Stones, gravel and clay ...	43.2%
Boulders & rocks	1.8%
Solid rock	1.6%
Total	100%

It is expected that dredging improvements will, to a large extent, be permanent once the control of spring and summer floods has been accomplished. The removal of shallow spots in the present channel, and the straightening of the channel by cutting through low bars will, by increasing the velocity of the current at such points, cause the scouring of the bottom and thereby prevent sediment accumulating.

Diversion and Bank Protection Works.

Sites. Works of this nature are proposed in places where the deep water channel crosses from one side to the opposite side of the river; where the presence of shifting sand bars in responsible for constant changes in the river bed; and where islands divide the flow into several channels. They will be located mainly in the reach from the Vermillion River to Prince Albert in which section these conditions mostly prevail.

Description. A typical design of diversion works proposed is shown on Plate 'F'. The following is a brief description of same:-

Two parallel rows of heavy piling, 9 feet apart, with piles spaced 5 feet centres on the upstream side, and 3 feet centres on the down stream side, are braced every 15 feet, the piling being held by securely bolted top and bottom wales. Piers, weighed down with stone resting on a platform, are placed within the piling every 60 feet. End piers are reinforced with extra piling, as also are the piers marking the change of alignment of each section of the dyke. Poplar poles, 3 to 4 inches in diameter, are nailed down to the down-stream wales to form a screen, the purpose of which is to retard the flow and to cause sedimentation below the works.

Effect of Dykes. By disposing works of the type described, at a proper angle with the direction of the current, a large percentage of the silt and sand carried by the spring and summer freshets will deposit in the pools downstream, forming bars, which in time will extend to the shores and prevent, to a large extent, the destruction of banks by erosion. The compact dyke, formed by the accumulation of silt and debris within the piling, will divert and increase the flow in a fixed direction, and close minor channels between islands, where these are found necessary.

Works as designed are intended to be permanent. They will be safe against the excessive strains due to ice shoves or driftwood fields, on account of being submerged when the spring and summer floods take place.

Location and Cost. Locations of proposed dykes are shown in red on charts of the river (Plates 1 to 59). The sites, however, are subject to revision owing to changes that have taken place in the river bed following the very heavy flood of 1915.

The total estimated cost of diversion works, based on the number and lengths of dykes required at the time the survey was made, amounts to approximately $1,360, 674.00. No less than 108 separate dykes having a total length of 142,800 feet, or over 27 miles, are provided for in the above estimate.

The detailed estimate on page 64, shows the cost of such works to be about $9.26 per lineal foot. A list giving the location, length and cost of each work, appears on page 65 and following.

Dams, locks and canals.

Cost. For the permanent improvement of six of the series of rapids between Prince Albert and Lake Winnipeg, the construction of dams, locks and canals is proposed, which will involve a total expenditure of approximately $14,565,320.00.

The general arrangement of structures at La Colle Falls, the Forks, the Tobin and Squaw Rapids, the Demi Charge Rapids, the Red Rock Rapids and the Grand Rapids, is shown on Plates C-1 to C-6. Details are omitted as new surveys with contours, test borings, etc., will be required at a later date when the final plans are being prepared. Preliminary plans, however, show the best means of safeguarding navigation and power interests where improvements are contemplated, and will be found ample for the purpose intended, i.e., for an approximate

estimate of the cost of permanent works at the above named rapids.

Dimensions of Locks - Construction. A minimum length of 250 feet between inside gates, and a width of 50 feet clear between lock walls, is proposed for all lift locks in the river, and the depth of water over mitre sills is to be in every case not less than 10 feet at low water.

All locks are to be of concrete construction, of standard design, and equipped with modern appliances for their operation. Approach piers of suitable length, constructed of crib work underwater and topped with concrete walls rising 3 to 4 feet above high water.

Type of Dams. Hollow concrete dams of the Ambursen type are proposed at all sites, except at the Demie Charge Rapids, where a stop-log dam, similar to the Chaudiere Dam at Ottawa, is contemplated. Proposed dams at the Colle Falls, The Forks, and the Squaw Rapids, will rest on a hardpan foundation, rock being at an unknown depth in these localities. The Demie Charge and Grand Rapids dams will be insured of a secure foundation on account of rock being accessible at no considerable depth.

Canals, width, etc. A bottom width of 100 feet is provided for in all canals. Wherever practicable, banks will have slide slopes of 1½ horizontal to 1 vertical; but wherever rock is encountered, the side walls will be cut vertically. The finished depth will be 6 feet in the canals of the upper river, and 10 feet in those of the Lower Saskatchewan.

Canals in the upper river will be excavated in alluvial soil, rock showing nowhere in the surrounding region. At the Demie Charge, Red Rock and Grand Rapids site, excavation will be entirely in solid rock, (limestone) overlaid in places with shale and light soil.

NORTH SASKATCHEWAN IMPROVEMENTS.

TYPICAL DIVERSION & BANK PROTECTION WORKS.

ESTIMATE FOR SECTION 309 FEET LONG.

BILL OF TIMBER.

208 Piles 25' long - 5200 lin. ft. @ 20¢	$ 1040.00
208 Piles @ 50¢ per pile driven	104.00
10 Cross braces 10" x 10" x 26' - 2165'BM @ $35)	
41 Wales 10" x 10" x 30' - 10250' ")	
3 " 10" x 10" x 18' for piers 450')	
12865 ' @ $35	450.27
24 Cross braces 10" dia. 12'.3" - 294 l.ft. @ .20	58.80
4 Wales 8" dia. 9' long - 36 " @ .20	7.20
16 pieces 6" dia. 8' long - 128 " @ .20	25.60
2 braces 8" x 8" x 26' - 52 - 277 ft. B.M. @ $35	9.69
6 Wales 10" dia. 18' long - 108' @.20	21.60
6 Cross braces 10" dia. 9' long 54' @.20	10.80
45 pieces ballast floor 6" dia. 8' long - 360' @ .05	18.00
369 pieces screens 4" dia. 15' long - 5535 @ .05	276.75
	$ 2022.71

STONE FILLING

54 Cords Stones @ $6.00	$ 324.00

BILL OF IRON

60 bolts ½" dia. 21" long U.H. - 165 lbs.)		
548 " 3/4" " 23" " " -1644 ")		
22 " 3/4" " 29" " " - 81 ")	1890 lbs. @ 6¢	113.40
630 nuts ¼ lb. each - 157 lbs. @ 10¢		15.70
1260 C.I. Washers - 1461 lbs. @ 7¢		102.27
570 Wire spikes - 114 lbs. @ 6¢		6.84
		$ 238.21

Material	$2584.92
Labour	276.78
Total cost	$2861.70

$\frac{2861.70}{309}$ ± $9.26 per lin. ft.

NORTH SASKATCHEWAN RIVER IMPROVEMENTS

List of Diversion and Bank Protection Works

No.	Miles from Edmonton	Length of Works	Estimated Cost	Remarks
1	22½	1000'	$ 9,555.00	
2	44¼	500	4,630.00	
3	117½	500	4,925.00	
4	140	1200	11,407.00	
5	147 3/4	1400	13,554.00	
6	177	1000	9,260.00	
7	179¼	900	8,334.00	
8	199½	2600	24,961.00	
9	203½	1300	12,333.00	
10	205	2000	19,110.00	
11	207	1300	12,333.00	
12	208¼	1300	12,628.00	
13	209¼	1400	13,554.00	
14	210½	1600	15,111.00	
15	213¼	2500	24,035.00	
16	214½	1500	14,480.00	
17	217 3/4	1600	15,111.00	
18	219¼	2800	26,518.00	
19	221 3/4	1400	13,554.00	
20	223	700	6,482.00	
21	237¼	2000	19,110.00	
22	239	1600	15,406.00	
23	241 3/4	1100	10,776.00	
24	243 3/4	1900	18,184.00	
25	244	1500	14,185.00	
26	245	1500	14,185.00	
27	248	2000	19,110.00	
28	249	1000	9,555.00	
		41100'	$392,386.00	

No.	Miles from Edmonton	Length of Works	Estimated Cost	Remarks
		41100'	$392,386.00	
29	249½	800	8,003.00	
30	251	1600	15,406.00	
31	252½	1400	13,259.00	
32	256¼	1800	17,258.00	
33	258	2100	20,036.00	
34	259½	1400	13,259.00	
35	261¼	1400	13,554.00	
36	262 3/4	1100	10,766.00	
37	265¼	1200	11,407.00	
38	267½	1000	9,260.00	
39	268¼	2000	18,815.00	
40	271	1100	10,766.00	
41	271 3/4	1000	9,260.00	
42	272 3/4	2000	19,110.00	
43	274	500	4,630.00	
44	274½	400	3,704.00	
45	275	1200	11,112.00	
46	277½	1000	9,555.00	
47	281¼	500	4,630.00	
48	282 3/4	1200	11,407.00	
49	283½	2000	18,815.00	
50	285	1500	14,480.00	
51	286	900	8,629.00	
52	287¼	1500	14,480.00	
53	288¼	2400	23,109.00	
54	291	200	1,852.00	
55	291¼	200	1,852.00	
56	291 3/4	1200	11,407.00	
57	292 3/4	1200	11,407.00	
58	302½	600	5,556.00	
59	304	1100	10,481.00	
		78600'	$749,651.00	

No.	Miles from Edmonton	Length of Works	Estimated Cost	Remarks
		78600'	$749,651.00	
60	307 3/4	2600	24,371.00	
61	308¼	1400	13,259.00	
62	311	1600	15,406.00	
63	313¼	1600	15,111.00	
64	319	1800	17,258.00	
65	321	2100	20,034.00	
66	322¼	1500	13,890.00	
67	322 3/4	300	2,778.00	
68	326	1100	10,481.00	
69	327	400	3,704.00	
70	327 3/4	1500	14,185.00	
71	331	400	3,704.00	
72	332	1200	11,112.00	
73	336 3/4	500	4,630.00	
74	339½	2000	19,110.00	
75	357¼	2000	19,110.00	
76	359½	1700	16,332.00	
77	361 3/4	1100	10,776.00	
78	365	1600	15,406.00	
79	369	1500	14,480.00	
80	371½	2000	19,405.00	
81	377 3/4	2100	20,034.00	
82	381	1200	11,407.00	
83	386	1800	16,668.00	
84	388 3/4	1500	14,185.00	
85	390	2300	21,888.00	
86	393¼	1000	9,260.00	
87	397	900	8,629.00	
88	400 3/4	800	8,003.00	
89	401¼	1400	13,259.00	
90	405¼	1500	14,185.00	
		123000'	$1,171,711.00	

No.	Miles from Edmonton	Length of Works	Estimated Cost	Remarks
		123000'	$1,171,711.00	
91	409	1800	16,963.00	
92	411	1000	9,555.00	
93	412 3/4	1000	9,555.00	
94	414 3/4	900	8,629.00	
95	417	800	7,408.00	
96	421	800	8,003.00	
97	439 3/4	1000	9,260.00	
98	443½	800	8,003.00	
99	446	600	5,556.00	
100	456½	400	3,704.00	
101	456 3/4	1000	9,555.00	
102	457½	400	3,704.00	
103	458½	1000	9,555.00	
104	468 3/4	900	8,629.00	
105	478 3/4	600	5,556.00	
106	496¼	1600	15,406.00	
107	502 3/4	1400	13,259.00	
108	670 3/4	3800	36,663.00	
	Total	142800'	$1,360,674.00	

Rapids above La Colle Falls Dam.

Upon the completion of the works undertaken by the City of Prince Albert in connection with the development of Hydro-Electric Power at "La Colle Falls", five of the first rapids of the series, viz: The Peace, Big Stone, Squaw, Demie Charge, and Rapid No. 5, will be flooded out and the new level established will afford ample depth for navigation for a distance of 6 miles above the dam.

Cost of completing lock and dam. The estimated cost of completing the unfinished portions of the City's lock, dam and spillway for the requirements of navigation alone. i.e., without regard to any ultimate power development, amounts to $325,000 approximately. This sum is made up as follows:-

	Cost to complete.
Dam and spillway	$287,139.00
Lock	21,355.00
Gathering plant repairing south lock wall, &c., say	16,506.00
Total	$325,000.00

The general estimate on page 83 provides for this expenditure, as in the event of the City of Prince Albert being unable to carry out their power development, the Government may be called upon to complete lock and dam.

To enlarge the present lock to standard size (2509 x 50') an additional expenditure of approximately $125,000 will be involved. This amount does not appear in the estimate, as a larger lock will probably not be required here for a number of years after the upper part of the river has been made navigable.

The general layout of improvement works at La Colle Falls, with profile of river, typical section of dam, etc., is shown on Plate C-1. A description of same will be found in the chapter dealing with "POWER & STORAGE", page 86 and following.

Rapids above "The Forks"

It is proposed to overcome the remaining rapids of the La Colle Falls series below the tail race of the Prince Albert Power Works, by the construction of a dam with locks and canal, as shown on Plate C-2.

Dam. A concrete dam built at the foot of the last rapids at "The Forks", having a 900 foot spillway at elevation 1290.0(N.S.R.S. datum) and raising the water 60 feet to elevation 1295.0 under normal conditions, will flood all rapids above for a distance of 8 miles. The crest of dam at elevation 1305.0 will allow of a 15 foot flood discharging over the spillway. To pass abnormal floods with additional safety, four sluiceways are provided for at the east end of the spillway.

Locks and Canal. It is proposed to locate a flight of three locks, each of 22 feet lift, on the west bank of the Saskatchewan about ½ mile below the Forks. The arrangement shown provides for locks of the standard size (250' x 50') with 10 ft. of water on sills, and crib piers at the lower and upper entrances carried to the elevation of the lock copings. A double set of gates will be placed at the entrance to the upper lock.

The canal connecting the locks with the reach above the dam follows closely the curved contour 1297. Excavation to grade 1285.0 will give a depth of 6 feet of water in the canal during the winter months when the spillway is discharging a minimum of 1,000 c.f.s. During the season of navigation (May to November) when the minimum discharge varies between 5,000 and 7,000 c.f.s. the depth of water in the canal will be from 8 to 10 feet.

The entrance at the upper end of the Canal is placed in the dam. A crib pier 500 feet long will serve as a protection to vessels when entering or leaving the canal. Gates are

provided here for the unwatering of the canal.

Made banks are to be raised to the level of the lock copings; and the spoil material from canal prism will be utilized for embankments. Excavation is chiefly clay with some surface loam; and properly packed this will afford excellent material for embankments.

Estimate for Improvements. The estimate cost of proposed improvements amounts to approximately $2,779,470. Items forming this amount are given in the preliminary estimate on the following page.

Improvement of Tobin and Squaw Rapids.

A concrete dam, about 2400 feet in length with a flight of three locks of even lift, at the location shown on Plate C-3, is proposed to overcome the Tobin and Squaw Rapids, and for the improvements of a reach of 47 miles above those rapids.

With a 1000 foot spillway at crest elevation 968 (N.S.R.S. datum) such a dam will permit of the raising of the water from elevation 916.5 to elevation 984.0 or 68.5 ft., whilst providing a discharge of 213,000 cu. ft. per second with 16 feet of water passing over the spillway. This discharge is the greatest known during flood periods on either branch of the Saskatchewan River.

To insure safety against the combined maximum floods of these rivers, an elevation of 994 for crest of dam has been adopted and is considered ample for any emergency.

Locks are to be of concrete of the standard size (250' x 50') with 10 feet of water on sills. Guard gates and crib piers are provided at both entrances, as shown.

A small amount of dredging will be required at the lower entrance, and some 115,000 cubic yards of dry excavation in the upper reach, to secure a minimum depth of 6 feet in the channel, as will be seen on examination of the profile.

NORTH SASKATCHEWAN RIVER SURVEY.

PRELIMINARY ESTIMATE

FOR IMPROVEMENT AT "THE FORKS" (MILE 531.)

Raised water, elev. 1295.0 - Dam and three locks, Lift 60 ft.

Description	Quantities Cu. Yds.	Price	Cost	Total
Concrete Dam.				
Length 1300', Spillway 900'				
Concrete	119,600	10.00	1,196,000.	
Excavation dry	99,200	.50	49,600	
Unwatering - Bulk sum			150,000	
				1,395,600
Flight of three locks & Approaches				
Crib entrance Pier (500 l.ft.)	8,740	3.00	26 220	
Earth excavation	82,000	.35	28,700	
Loose rock excavation	82,000	.75	61,500	
Lockgates (1 pair)		11,000	11,000	
Upper Entrance				
Crib entrance Piers (400 l.ft.)	4,400	3.00	13,320	
Locks (50 x 250)				
Excavation dry in lockpit No. 1	21,000	.60	12,600	
Excavation dry in lockpit No. 2	25,000	.60	15,000	
Excavation dry in lockpit No. 3	22,000	.60	13,200	
Concrete in lock No. 1	27,000	10.00	270,000	
Concrete in lock No. 2	22,000	10.00	220,000	
Concrete in lock No. 3	24,000	10.00	240,000	
Unwatering lock No. 3 - Bulk sum			10,000	
Backfilling around locks &	30,000	.35	10,500	
lockgates (5 pairs) - works		11,000	55,000	
Valves and machinery			32,000	
Operating machinery for locks			22,000	
Lock houses, surfacing, bollards lights, etc.			22,000	
Lower Entrance				
Crib entrance Piers (200 - 500 - 700 lin. ft.)	18,400	3.00	55,000	
Excavation	37,000	.35	12,950	
				1,131,190
				$ 2,526,790
Engineering & contingencies 10%				252,680
Total				$ 2,779,470

Estimate. The estimated cost of works outlined above amounts to $4,349,380. A detail of this estimate is given on the following page.

Demie Charge Rapids (Lower Saskatchewan) Dam.

By reference to Plates 58 and C-4, it will be readily seen that 6 foot navigation, the Demie Charge Rapids can best be overcome by simple lockage with canal. In connection, however, with the creation of a 10 foot navigation between Le Pas and Lake Winnipeg, which is here considered, a scheme involving the regulation of Cedar Lake by means of a stop-log type of dam, as shown on Plate C-4, is proposed.

With a head of 8 feet on a spillway 1800 feet long at elevation 828 (our datum), a solid dam at the location shown discharging freely - which is impracticable in this instance - would take care of about 150,000 cubic feet per second, which is regarded as the maximum flow of the river here. As a submerged weir, the design adopted, i.e. stop-log dam 2600 feet long, with crest elevation 828, and 80 piers, 5 feet thick, would discharge this maximum flow after allowing 4% for end contractions.

Regulation of Cedar Lake Level. By means of such a structure, the level of Cedar Lake could be maintained between elevations 834 and 836 without incurring damage by flood conditions, high water at the east end of the lake being estimated at 838 or 2 feet higher. The raised level would establish a 10 foot navigation system for lake vessels as far as Le Pas, without increasing the cost of dredging necessary for a 6 foot navigation the difference in cost between the two systems being in the initial cost and maintenance of the dam only. The new level, moreover, would allow of continuous navigation across the lake - which, at present, is not possible for flat bottom boats, on account

NORTH SASKATCHEWAN RIVER SURVEY

PRELIMINARY ESTIMATE

FOR IMPROVEMENTS AT TOBIN & SQUAW RAPIDS (MILE 655)

Raised water, elev. 984 - Dam and three locks. Lift 68.5 feet.

Description	Quantities Cu. Yds.	Price	Cost	Total
Concrete Dam				
Length 2400' Spillway 1000'				
Concrete	227,634	10.00	$ 2,276,340	
Excavation dry	168,700	.50	84,350	
Unwatering .. Bulk sum			100,000	$2,460,690
Flight of three locks & Approaches				
Channel above locks				
Earth excavation	80,000	.35	28,000	
Loose rock excavation	35,000	.75	26,250	
Upper Entrance				
Crib entrance piers (200 - 1000 - 1200 lin. ft.)	12,000	3.00	36,000	
Locks (50 x 250)				
Excavation dry in lockpit No. 1	20,000	.60	12,000	
Excavation dry in lockpit No. 2	27,000	.60	16,200	
Excavation dry in lockpit No. 3	31,000	.60	18,600	
Concrete in lock No. 1	43,300	10.00	433,000	
Concrete in lock No. 2	31,000	10.00	310,000	
Concrete in lock No. 3	37,900	10.00	379,000	
Unwatering lock No. 3 bulk sum			5,000	
Backfilling around locks &	30,000	.35	10,500	
Lockgates (5 pairs) - works		11,000	55,000	
Valves & Machinery			32,000	
Operating machinery for locks			22,000	
Lock Houses, surfacing			22,000	
Bollards, lights etc.				
Lower Entrance.				
Crib entrance piers (200 - 500 - 700 lin. ft.	23,660	3.00	70,950	
Excavation	48,000	.35	16,800	$1,493,300
				$3,953,990
	Engineering and contingencies 10%			395,390
			Total	$4,349,380

of the heavy seas running for days after a storm has subsided.

Canal & lock. The Channel, for the lockage system proposed, will be transferred to the east side of Centre Island, entering the bank near the head of a small low island (Plate C-4). Here a limestone ledge is found, and it is probable that rock exists also throughout the bulk of the cut above the lock, at elevation 820. At the present time, however, this is overlaid by a large quantity of muck, so that drainage would have to be resorted to during construction.

The lock has been placed at the lower end of the canal, near Cross Lake, which was found to be the most advantageous position. It will be of the standard size (250' x 50'), with 10 feet of water on sills, and have a lift of 20.5 feet. Crib approaches are provided, as shown, and are carried level with the copings of lock (elev. 840) in the upper reach. Made banks extend on both sides of the canal from the upper end of lock, north for 1,500 feet, to high ground. The canal is to be 100 feet wide at the bottom and 10 feet deep at low water. The excavation for this canal is expected to be mostly in rock.

Some dredging will be required at both ends of the canal as shown. The rock fill at end of stop-log section of dam will be made from material dredged, the canal banks being built from material taken from canal prism.

Estimated Improvements at Demie Charge Rapids. The estimated cost of improvements at the Demie Charge Rapids is given as $1,837,400. A detailed statement of items forming this amount appears on the following page.

Red Rock Rapids.

It is proposed to overcome these rapids by a single lock with canal, the general arrangement of which is shown on Plate C-5.

A dam at the head of the rapids - which is the only site available - is considered unnecessary from the point of

NORTH SASKATCHEWAN RIVER SURVEY

PRELIMINARY EST.

FOR IMPROVEMENTS AT DEMIE CHARGE RAPIDS

Cedar Lake, raised water 834 - Dam, lock and canal - lift 18.5 ft.

Description	Quantities	Price	Cost	Total
Stop-log dam.				
(Length 2800')				
Excavation earth	C.yds 2,500	.50	1,250	
Excavation rock	" 15,000	2.00	30,000	
Concrete	" 50,000	10.00	500,000	
Cement finish on bridge	S.yds. 5,500	.75	4,125	
Drilling rock bolt holes	L.ft. 10,000	.50	5,000	
Foundation & anchor bolts	lbs. 180,000	.06	10,800	
Structural steel with SW	" 2000,000	.05	100,000	
Reinforcing rods	" 1200,000	.05½	66,000	
Steel nosings	" 200,000	.05	10,000	
Cofferdams & unwatering - bulk sum			50,000	
Floor, track, stop-logs & machinery			80,000	
				$857,175
Rock fill dam				
Length 800' at east end of stop-log dam				
Rock fill	C. yds 22,600	2.00	45,200	
				45,200
Earth fill dam - north of lock				
Earth fill	C. yds 20,000	.60	12,000	
				12,000
				$914,375
Canal & Lock				
Canal above lock				
Excavation earth to be used in embankment. Price includes overhaul	48,000	.50	24,000	
Excavation solid rock	48,000	2.00	96,000	
Embankment 52,000 c.y. made from above				
Upper entrance				
Crib entrance piers 700 l.ft.	C.yds 5,400	3.00	16,200	
Lock (50 x 250)				
Excavation earth dry in lock pit	7,000	.60	4,200	
Excavation solid rock in lock pit	14,000	2.00	28,000	
Concrete in lock	35,900	10.00	359,000	
Backfilling around lock & works	10,000	.35	3,500	
Lockgate (4 pairs)		11,000	44,000	
Valve & machinery			12,000	
Operating machinery for lock			8,000	
Lock, surfacing, bollards, light etc.			8,000	
Lower entrance				
Crib entrance piers 700 l. ft.	6,500	3.00	19,500	
Excavation solid rock dry	41,000	2.00	82,000	
Dredging solid rock	17,200	3.00	51,600	
				$756,000
				$1,670,375
Engineering & contingencies 10%				167,025
Total				$1,837,400

view of navigation. Such a dam could serve no other purpose than to drown out the Cross Lake Rapids and to add to the storage of Cross Lake.

A comparison of the cost of a canal with Dam drowning the Cross Lake Rapids, with the cost of dredging these rapids, necessary in connection with the canal and lockage system proposed, shows a difference in total Capital Cost in favour of the latter system. Moreover, as the Works designed to overcome the Grand Rapids, a few miles below, are intended for the safeguarding of a large amount of Power - probably more than can be utilized for a number of years - the development of additional Power at the Red Rock Rapids does not appear advisable.

Lock and Canal. The lower entrance to the lock is placed behind the gravel islands at the foot of the rapids proper; for safety, the upper crib entrance to the Canal is carried out in the River about ½ mile above the head of the rapids, to near Mile 929, as appears on plan.

The lock is to be of concrete, of the standard size (250' x 50') and designed for a lift of 14 feet, with 10 feet of water on the sills. Guard gates and crib entrance piers are provided for, as shown. Copings of lock, upper pier, and top of made embankment, are to be carried to Elevation 817 (our datum) to insure safety against excessive floods.

The Canal is to be 100 feet wide at the bottom, with earth slopes of 1½ to 1, and sides cut vertical where rock is encountered. At grade elevation 800, a 10 foot channel will be available at low stages.

A creek diversion will be necessary and is provided for, as shown.

EMBANKMENTS, ETC. Excavation in canal East of Creek will furnish the material for a long protection fill, largely of rock, in extension of the gravel bar North of the lower

entrance, and in the raising of same to high water mark.

A small amount of dredging will be needed below the lock. Excavation from the canal prism, probably mostly rock, will afford the material for canal embankment west of lock.

Plant, materials for construction, supplies, etc., may be brought up river by boat from the lower section, and laid down at the site of the lock when works at Grand Rapids have been completed.

ESTIMATED IMPROVEMENTS AT RED ROCK RAPIDS. The estimated cost of improvements at Red Rock Rapids amounts to $1,509,500.00. Items forming this sum are given in detail on the following page.

GRAND RAPIDS.

General. A site for a dam which has been considered by the Water Power Survey, probably because of the narrowness of the river and good quality of the rock, is situated at Mile 935 3/4 (plate 59).

It does not appear how a dam at this site will overcome anything except the most concentrated fall of the Grand Rapids, nor that it will be able to drown out the Red Rock Rapids without carrying wing embankments so far as to render the cost of such works prohibitive. The location of a power house, ¼ of a mile below the dam, on the other hand, is both suitable and safe.

The desirability of building a dam to utilize the greatest amount of head possible for power development, whilst reducing the cost of improvements to navigation to a minimum, has lead to the adoption of an alternative site further down River, at Mile 937, as shown on Plate C-6. The river here, is 1,200 feet in width, and the low water surface 739 (N.S.R.S. datum). The greater length of spillway at this site would provide an element of safety, the estimated discharge with a 4 foot head, being double the discharge recorded as a

NORTH SASKATCHEWAN RIVER SURVEY

PRELIMINARY ESTIMATE

FOR IMPROVEMENTS AT RED ROCK RAPIDS

Description	Quantities Cu. yds.	Price	Cost	Total
Canal above Lock				
Excavation Solid Rock wet	63,000	3.00	189,000	
Excavation Solid Rock dry	244,900	2.00	489,800	
Crib Entrance Pier	8,500	3.00	25,500	
Upper Entrance to Lock				
Crib Entrance Piers 700 l. ft.	6,000	3.00	18,000	
Lock				
Excavation in lockpit Solid	17,000	2.00	34,000	
Concrete in lock - Rock dry	31,900	10.00	319,000	
Backfilling around lock and	10,000	.35	3,500	
Lockgates (4 pairs). - works		11,000	44,000	
Valves and machinery			12,000	
Operating machinery for lock			8,000	
Lock houses, surfacing, bollard, lights, etc.			8,000	
Lower Entrance				
Crib Entrance Piers 700 l. ft.	6,000	3.00	18,000	
Excavation on Solid Rock dry	8,000	2.00	16,000	
Excavation on Solid Rock wet	62,000	3.00	186,000	
Creek Diversion				
Excavation Loose Rock dry	2,000	.75	1,500	
				$1,372,300
				$1,372,300
Engineering & contingencies, 10%				137,200
Total				$1,509,500

maximum at Grand Rapids in the year 1912.

The profile shows relatively slack water with medium depth. Danger from high water during construction is not so great as at the site above. A dam at this site, as compared with the one projected in connection with the development at the upper site, will save at least a mile of canalization.

The location for a Power House here is not ideal, but no doubt, a satisfactory site may be had by excavating into the bank.

DAM AND LOCKAGE SYSTEM. A concrete dam at Mile 937, raising the water 51 feet, with a series of 4 locks and canal, such as shown on Plate C-6, is recommended for the improvement of the Grand Rapids Section. The locks are to be constructed for the following lifts:-

Lock No. 1 - from Elev. 712	to Elev. 732 -	Lift	20 feet
Lock No. 2 - from Elev. 732	to Elev. 754 -	Lift	22 feet
Lock No. 3 - from Elev. 754	to Elev. 778 -	Lift	24 feet
Lock No. 4 - from Elev. 778	to Elev. 790 -	Lift	12 feet
		TOTAL Lift	78 feet.

Locks to be of concrete, 250 feet between sills and 50 feet wide with 10 feet of water on sills. Entrance piers of cribwork under water with concrete walls above. Canal to be 100 feet wide at bottom and 10 feet deep. A large basin between Locks Nos. 2 and 3 will be formed by two embankments, from waste material, extending across both ends of an old dry channel, as shown. Stop log regulation will permit of the unwatering of the basin, when necessary.

ESTIMATED IMPROVEMENTS AT GRAND RAPIDS. The estimated cost of works at Grand Rapids amounts to $3,764,570.00. Details of this estimate are given on the following page.

SUMMARY The total cost of improvements outlined above amounts to $20,765,591.00 approximately. The several amounts forming this total appear in the Summary, page 83.

NORTH SASKATCHEWAN RIVER SURVEY

PRELIMINARY ESTIMATE

FOR IMPROVEMENTS AT GRAND RAPIDS

Description	Quantities Cu. Yds.	Price	Cost	Total
Concrete Dam				
Length 1700' Spillway 1200'				
Concrete	97,440	10.00	974,400	
Earth excavation dry	19,200	.50	9,600	
Solid rock	39,200	2.00	78,400	
Unwatering - Bulk Sum			200,000	$1,262,400
Canal & Four Locks				
Locks Nos. 1 & 2				
(in flight) - 250' x 50' each				
Upper entrance piers - Crib (500 lin. ft.)	11,110	3.00	33,330	
Excavation dry in lockpit No. 2	15,000	.60	9,000	
Excavation dry in lockpit No. 1	25,000	.60	15,000	
Concrete in lock No. 1	33,000	10.00	330,000	
Concrete in lock No. 2	33,000	10.00	330,000	
Lower Ent. Piers Crib - 700 l.ft.	7,780	3.00	23,340	
Lockgates (3 pairs)		10,000	30,000	
Valves & Machinery			12,000	
Unwatering lock No. 1 - Bulk sum			5,000	
Operating machinery for locks			36,000	
Lock houses, surfacing, bollards, lights			32,000	
Backfilling around locks and works	60,000	.35	21,000	
Channel below Lock No. 1				
(12 ft. below L.W. at Lock to 6 ft. at Station 144.)				
Earth excavation	74,000	.35	25,900	
Solid Rock excavation	25,000	2.00	50,000	
Earth dam with Concrete Core Wall near Lock No. 2				
Earth fill	95,000	.60	57,290	
Concrete Core Wall & Regulation (stop-log)	8,850	10.00	88,500	
North Dam with Concrete Core Wall So. of Lock No. 3				
Earth fill	31,700	.60	19,020	
Concrete Core Wall & Regulation (Stop-logs)	3,770	10.00	37,700	$1,155,080
Lock No. 3 (250' x 50')				
Crib entrance Piers (1000 l.ft.)	8,660	3.00	25,980	
Excavation dry in lockpit	25,000	.60	15,000	
Concrete in lock	37,900	10.00	379,000	
Lockgates (2 Pairs)		10,000	20,000	
Valves & Machinery			8,000	447,980
	Carried Forward			$2,865,460

FOR IMPROVEMENTS AT GRAND RAPIDS (Continued)

Description	Quantities Cu. Yds	Price	Cost	Total
	Brought Forward			$2,865,460
Channel between Lock No. 3 and Lock No. 4				
Earth excavation to be used in embankment. Price includes overhaul	53,000	.50	26,500	
Solid rock excavation	26,500	2.00	53,000	
Embankment - borrow	10,000	.35	3,500	
Regulation (stop-log)			5,000	88,000
Lock No. 4 (250' x 50')				
Crib entrance Piers (1000 l.ft.)	8,660	3.00	25,980	
Excavation dry in lockpit &	50,000	.60	30,000	
Concrete in lock - regulation	28,000	10.00	280,000	
Lockgates (3 pairs)		10,000	30,000	
Valves & machinery			12,000	377,980
Channel above lock No. 4 100' wide & 10' deep				
2 cribs 20 x 40	600	3.00	1,800	
Earth excavation	66,000	.35	23,100	
Solid rock	33,000	2.00	66,000	90,900
				$3,422,340
	Engineering & contingencies, 10%			342,230
	Total			$3,764,570

NORTH SASKATCHEWAN RIVER SURVEY

SUMMARY OF

ESTIMATED COST OF NAVIGABLE WATERWAY

FROM EDMONTON TO LAKE WINNIPEG.

Channel (Edmonton to Le Pas, 150 ft. wide, 6 ft. deep
(Le Pas to Lake Winnipeg, 150' wide, 10' deep

WORKS	ESTIMATED COST
Dredging	$4,839,597.00
Diversion and Bank Protection Works (Edmonton to the Sturgeon River "Cut Off")	1,360,674.00
To complete City of Prince Albert's Lock and dam at La Colle Falls	325,000.00
Locks and dam at "The Forks"	2,779,470.00
Locks and dam at the Tobin & Squaw Rapids	4,349,380.00
Canal, lock and dam at the Demie Charge Rapids	1,837,400.00
Canal and Lock at the Red Rock Rapids	1,509,500.00
Canal, Locks and dam at the Grand Rapids	3,764,570.00
GRAND TOTAL	$20,765,591.00

N.M.

POWER AND STORAGE.

POWER AND STORAGE

GENERAL. The production of power on the North Saskatchewan River is both limited and costly. It is limited by the extreme low winter flow, which may be taken as about 1000 second feet at Edmonton, and by the relatively low head available at the foot of the various falls or rapids, and cost by owing to the necessity of constructing works designed to provide adequate storage and to be safe against a flood discharge of 200,000 second feet.

It is of doubtful utility to establish storage reservoirs in the Mountains with the sole idea of supplementing the low winter flow, for owing to the nature of the bottom, particularly above Edmonton, and the liability to the formation of frazil ice with backwater, overflow and surface freezing a good percentage of this water will be lost before it reaches the turbines. Such storage, however, may be carried out in connection with flood control and the River improvement scheme, and will prove valuable to Power interests along the River as a means of equalizing, to an appreciable extent, the head available throughout the whole of the year.

With two exceptions, namely, the sites at Pakan, and at the foot of the Tobin and Squaw Rapids, the storage of water at possible Power Sites below Edmonton appears impracticable. Even the "La Colle Falls" development for the City of Prince Albert, which, half finished at a cost of $900,000.00, and likely to cost in all $2,000,000.00 if completed, offers only 3,000 guaranteed horse power at low water and provides for practically no storage whatever.

As the ordinary river craft are not prepared to cope with velocities of 8 to 10 miles per hour in working up stream, it may reasonably be expected that such Power schemes as may by Locks and Dams improve the navigability of the River at the several Rapids, will be given substantial assistance from

the Dominion Government. If the Rapids which occur at intervals for 150 miles below Edmonton, and again below Prince Albert, are to be effectively improved by private interests, it is evident that the cost not of the Locks alone, but a large share of the cost of the Dams as well, is properly chargeable to river improvements.

PAKAN POWER SITE. A site exists about 75 miles from Edmonton in the Pakan Sandstone ledges, where it may be possible not only to build a dam 75 feet high above low water surface, with two locks, but also to secure thereby a storage of 200,000 acre feet.

During three months this storage might be so manipulated as to provide works in the river below - such as Prince Albert has undertaken - with the water that would assure an extra 1000 Horse Power along its route, without lowering the capacity of a plant established at the dam itself to less than 4000 Horse Power for the entire year. This means that 4000 H.P. could be readily delivered at Edmonton by a 75 mile transmission line all the year around. Substantial Government aid, however, would be required in order to assure Edmonton the power at an attractive rate, say of $50.00 a Horse Power.

MOOSE RAPIDS SITE. Though the proposed navigation scheme does not call for an improvement of the rapids between Hopkins and Moose by means of Locks and Dams, should the construction of such works be undertaken later, a substantial amount of Power - probably from 3,000 to 4,000 Horse Power - would be available at the foot of the Moose Rapids. No considerable storage, however, is possible here, as in the case of the Pakan Site.

The nearest market for this power would be in the St. Paul des Metis District, some 35 miles distant.

Moose Rapids are about 160 miles from Edmonton.

<u>SITE AT "THE ELBOW".</u> Storage, combined with marked improvement in navigability, can be secured at "The Elbow". In the district between Battleford and "The Elbow", the wide river bed and high banks are well adapted for storage purposes. By raising the water some 35 feet at The Elbow, a very large reservoir, about 70 miles in length, would be formed, and would serve the interests of both navigation and Power as well.

The works at this point, in order to deal effectively with the large quantities of silt carried by the water, would have to be provided with a number of sluiceways similar to those on the Assouan Dam on the Nile or a succession of Stoney Gates. They would be of distinct advantage to the Prince Albert plant, raising its capacity from say 3,000 H.P. to 5,000 H.P. and would also serve Saskatoon or Battleford with some 5,000 Horse Power.

The cost of a dam at "The Elbow" would, however, be so high as to offset the advantage in navigability and power derived through the construction of works of that kind.

<u>"LA COLLE FALLS" DEVELOPMENT.</u> The Hydro-Electric Plant of the City of Prince Albert is located on the North Saskatchewan River, 29 miles below the City. At this point there is a total fall of 19.4 feet in 3 miles of River. The first five Rapids of the La Colle Falls series occur in this three mile reach.

The obtainable Power at the site, originally estimated at about 11,200 Horse Power, cannot be said to exceed 3,000 effective Horse Power. Systematic meterings conducted at Prince Albert since 1911 give an average minimum winter flow of from 1,000 to 1,500 c.f.s. and in one instance, in 1914, a flow as low as 850 c.f.s. is on record. These figures show that in low water years no more than 2,000 E.H.P. can be depended upon for delivery at the city sub-station during the three winter months.

The following description of the Plant, taken from the Report of the J.G. White Engineering Corporation, New York, the Experts engaged by the City of Prince Albert to report on the development, will give a general idea of the main features of this undertaking:-

"The plant as laid out consists of a diversion dam, at the South end of which is a lock for navigation purposes. At the north end of the dam is the intake structure. This controls the entrance of water to the canal, which is located along the northerly side of the river, and generally about 800 feet away from it. The power house is located on the canal about 2,000 feet below the intake, and is connected again to the river by a trail race about 1,650 feet long. (See Plate C-1).

"The dam is a hollow concrete structure of the Ambursen type having a length of spillway of 755 feet, and is about 30 feet high above the bottom of its foundation, raising the water in the river about 20 feet. Provision is made for raising the water an additional two feet by flashboards. The total base width of the dam is 119 feet, of which about 66 feet is a concrete apron below the dam. The dam is divided into 50 bays, each having a usual length of 15 feet from the centre to centre of buttress. Six 8'x12' Stoney sluice gates are to be placed in alternate bays at the bottom of the dam at its northerly end. The dam is founded on a very hard clay in which are buried occasionally small boulders.

"The lock is a massive concrete structure designed for a lift of 23 feet at working water level. The lock chamber has an available length of 135 feet, and is 40 feet wide. The total length to the ends of the shore retaining walls is 506 feet.

"The intake structure is of reinforced concrete 179 feet long, flanked at each end by extensive retaining walls. Provision is made for eight openings, each 18 feet wide, which

are to be controlled by stop logs. Suitable racks are provided for and a reinforced concrete hood is to be constructed across the openings so that the water will enter 5½ feet below the normal water surface.

"The canal is about 2,000 feet long, with a base width of 58 feet and side slopes of two horizontal to 1 vertical. The capacity of the canal, with water 15 feet deep and a slope of 1 foot in 2,000 feet as proposed, will be about 8,300 c.f.s., when free from ice, and about 4,500 c.f.s. when covered with three feet of ice. The slope in the canal when carrying sufficient water (about 2,000 c.f.s.) for the initial installation, will be about three inches in its length of 2,000 feet, and the velocity of flow about 1.5 feet per second.

"The power house is designed to accommodate three turbine units of 2,500 horsepower, with the necessary generators, exciters, transformers, switchboards, etc. The building will be of concrete construction and only two turbines will be installed in the initial installation.

"The tail race is about 1,650 feet long with a base width of 46 feet, and side slopes of two horizontal to one vertical for a depth of 15 feet, above which the slopes are 1½ horizontal to one vertical. The tail race as laid out has sufficient capacity to carry the 2,000 c.f.s. required for the initial installation of 5,000 horse power when free from ice, but unless the channel erodes, some head will be lost when it is covered with ice.

"In the initial installation it is proposed to install two turbines of the vertical type of 2,500 horse power each. At 80 percent efficiency and with 28 feet of head about 2,000 c.f.s. of water will be required to operate these turbines. Allowing for losses at generator step-up and step-down transformers and for transmission, about 4,000 E.H.P. (24 hour power) will be available at the Prince Albert sub-station when there is sufficient flow in the river.

"Work on this development was started during the summer of 1912, and closed down owing to lack of funds, on August 29th, 1913. Construction work completed on that date amounted to about 40 per cent of the entire works. The cost of the completed Power Works will exceed $2,000,000.00."

POWER AT "THE FORKS". Of the 90 feet of drop in 12 miles to be negotiated throughout the entire series of La Colle Rapids, a good 60 feet remains after making adequate allowance between tail race of the Prince Albert Development and a pond level at "The Forks", 9 miles further down river, to initiate another development.

The Works designed for navigation improvements at the Forks, shown on Plate C-2, provide for this development. With a minimum flow of 1,000 cubic feet per second all year and a working head of 40 feet, the development of 3,300 Efficient Horse Power is possible at this site.

Practically no storage is available in the reach, the valley being narrow and winding and confined everywhere within high clay banks.

Just below the foot of these rapids, the South Saskatchewan flows in with a practically equivalent water shed, and a minimum winter flow likewise of 1,000 second feet.

CADOTTE AND NIPAWIN RAPIDS. The possible power site at Mile 594½ examined by the Dominion Water Powers Branch, would not appear to be very satisfactory; the same may be said of site at Mile 595½ unless a dam at this site were combined with another dam lower down. Ice appears to have considerable action at the first named site but is in less evidence on the lower Rapids.

A dam 1,500 feet long at Mile 599½, Chart No. 40, will make a great amount of storage available. The water may be raised to Elevation 1076 by this dam, and all high water is provided for at the site.

No other dam site on the Nipawin Rapids will render any considerable amount of storage available. An Elevation of 1052 on the middle or lower Nipawin will however drown out the Cadotte Rapids. Such a dam near Mile 597 would by canalization, provide an extra 5 feet of fall, but at a greater expense than a dam at Mile 598 carried to the same Elevation 1052 and overcoming all rapids. Canalization to shallow depth might however be employed at Mile 597 to take care of possible high water.

Either of these dams would be 1,200 feet long.

The range between High and Low water may be generally taken at 15 feet in this section of River.

TOBIN AND SQUAW RAPIDS. The only other Rapids which offer a heavy obstacle to navigation in the Saskatchewan between Prince Albert and Le Pas, are the Tobin and Squaw Rapids, 150 miles below Prince Albert. At these rapids the river is very shallow and drops some 38 feet in 7 miles, the current in spots running from 8 to 10 miles per hour.

As a power proposition in connection with navigation improvements, this site will yield, figuring on a 75% efficiency, a minimum of 5,000 Electrical Horse Power, with a minimum flow of 2,000 c.f.s. all year and a working head of 35 feet.

The basin created by raising the water at the foot of the Squaw Rapids, as shown on Plate C-3, will provide a large amount of storage.

By taking advantage of a couple of short ridges on the north bank, excavation will allow of an intake at right angles to the river, and provide protection and shelter for a Power House and Tail Race.

The absence of a ready power market within a reasonable distance and transmission line expense, would indicate that as a commercial enterprise, a development at this site is unadvisable for a number of years to come. A pulp mill could

be established nearby, as there are large areas of timber presumably of paper making grade in the neighbourhood.

<u>DEMIE CHARGE, RED ROCK and GRAND RAPIDS.</u> The three power sites on the Lower Saskatchewan between Cedar Lake and Lake Winnipeg, namely:- the Demie Charge Rapids, the Red Rock Rapids, and the Grand Rapids, will be adversely affected by the Pasquia Reclamation project of the Dominion Water Power Branch which involves the lowering of Cedar Lake some 12 feet. At the Demie Charge, the loss of head <u>alone</u> will render the site practically useless as a power proposition, whilst developments at the Red Rock and Grand Rapids will suffer considerably owing to diminished storage in Cross Lake.

As a storage reservoir, Cedar Lake offers an area of approximately 425 square miles at present. Moose Lake, which flows intermittingly into Cedar Lake, has an approximate area of 513 square miles. The combined capacities of these reservoirs therefore amounts to some 938 square miles. The eliminating of a large percentage of this storage in Cross Lake.

As a storage reservoir, Cedar Lake offers an area of approximately 425 square miles at present. Moose Lake, which flows intermittingly into Cedar Lake, has an approximate area of 513 square miles. The combined capacities of these reservoirs therefore amounts to some 938 square miles. The eliminating of a large percentage of this storage by the lowering of Cedar Lake will materially reduce the capacities of Plants further down river, notwithstanding the possible storage in Cross Lake with its area of 39 square miles.

At the Demie Charge, under present conditions, a development of 4,000 to 8,000 Horse Power is possible, depending upon the stage of Cedar Lake.

Assuming a minimum flow of 3,000 sec. ft., the Red Rock Rapids will provide 3,750 Horse Power by raising the water 15 feet at the foot of the Rapids. A dam at this point, however, is not contemplated in connection with navigation improvements.

As the waters stand now, Grand Rapids with a fall of 60 feet in 4 miles, and a minimum flow in this part of the Saskatchewan of probably 3,000 second feet, should provide from 15,000 to 25,000 Horse Power, irrespective of any allowance for storage in the Cedar and Cross Lakes.

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A P P E N D I X "A"

ESTABLISHMENT OF LOW WATER PLANE

By G. P. MORSE
Assistant Engineer

APPENDIX "A"

ESTABLISHMENT OF LOW WATER PLANE

By G. P. MORSE
Assistant Engineer.

The establishment of a Low Water Profile over 900 miles of River is a matter of considerable difficulty. That such an undertaking should or could be related in any way to flood conditions is not at first apparent.

Mention has been made of the diversion of the waters now flowing from the Cut Off into Cumberland Lake, whence mingled with the waters of many streams they issue by two more (The Bigstone and Tearing River Outlets) to join their proper Channel at widely separated points. Changes of general Profile are moreover introduced by various series of Rapids, of which the Colle Falls series present the greatest obstacles to navigation. The South Saskatchewan, drawing an approximately equivalent watershed, is met by the North River at the foot of these Rapids and the enlarged stream has its flow through a very sparsely settled country for the next 200 or 300 miles.

The greatest difficulty was encountered in establishing permanent gauges and getting same read at proper intervals. Gauges have been set and carried away by floods repeatedly in a single season. The only boat available for the work of setting gauges was the small oil launch "Lafleur" which was also depended upon for provisioning parties operating over various sections.

The ideal method of establishing a Low Water Profile is well known. It contains in the placing of a gauge, self-recording, every 2 miles or so along the Rivers gentler reaches, and one at the top and bottom of every Rapid and every Lake-like expansion; also at the beginning and end of every well-defined separation of channels, all tied in

to a set of precise levels;- and the securing of these readings, with adequate inspection, over a period of many years.

Needless to say, such an expensive scheme was not attempted in connection with this Survey; the information on River Profile accompanying this report is therefore of a somewhat approximate character. It has however, been the aim to establish a profile that would be correct within one foot; and if care be exercised in not dredging the wier-like clay bars too deep while work is in the experimental stage, it is believed that this Profile will serve its intended purpose.

We have indeed a system of precise levels from Edmonton to Le Pas reduced to a datum of our own (2000 assumed) at Edmonton; and for some stretches of two hundred miles these benches are found not more than two miles apart, while at the time of placing the benches water-elevations were recorded and in connection with gauges at supposedly governing points, these formed the basis of an approximately low water profile for the year 1910. I may say that the water was normally low in the latter part of the 1910 season reaching 2001 at Edmonton on November 1st, and although we have no intention of assuming that it is absolutely the lowest stage the River above the Forks has ever shown on November 1st, the figure 2000 being one foot lower at Edmonton, has been adopted as the basis of our low water Profile there; likewise at Vermilion, Battleford, Prince Albert, and wherever else gauges have been located above the Forks, the 1910 water less one foot has been adopted. This was justified in subsequent years.

In 1910 we were able to establish only 9 permanent

gauges in the 900 miles between Edmonton and Lake Winnipeg. The boat Lafleur gave poor satisfaction that year and was re-modelled the following winter. The gauge at the Forks went out and was not read to the Low Water Season. The water readings taken by the Level Party therefore gave no adequate idea of the Low Water Plane below the Forks in that year. The Pas Gauge read 847.1 at end of season which is 1.1 higher than the Low Water we have adopted for that point. But in 1911, when gauges above the Forks showed practically low water stage, the Pas showed 4.0 ft. above the adopted L.W.P. and Pemmican Portage gauge in the Main River opposite Cumberland showed 4.5 higher than the Low Water Plane there which has been fixed at 861.4.

The year 1912 showed Prince Albert 1370.1 on November 1st, being 0.1 above adopted Low Water. The corresponding reading for Le Pas was 6.0 above L.W.P. 846.0.

It is evident that a part of these differences may be attributed to the effect of the South Branch, but late in the season they are probably due to the so called "North" water that comes in from Cumberland Lake.

Again in comparing the gauge books from Edmonton and Battleford it was evident that the extreme rise (or fall from flood elevations) was only about half at Battleford what it was at Edmonton. Yet no large tributary stream intervenes.

Hence even with the taking of water elevations at close intervals as in 1910 an interpretation by the gauges of these two places would show wide discrepancies at Low Water Plane, and interpolation is the usual resort. This, however, is believed to be less accurate than the method we finally adopted.

Briefly the suggested method of gauging for Low Water Plane is this:- Conduct a continuous gauge from Camp to Camp as the Sounding Crew progresses down River, reading gauge immediately before leaving and immediately after setting camp, the effect being that of a series of Gauges about 4 miles apart. This natural combining of the effects of altered channels and banks and grades will be found to give a more consistent profile for long distances, when the gaugings are applied to water levels run from benches, than can be produced by adjusting between single gauges separated by the entire distance, and the method is adaptable to various emergencies. It is believed that for these increments of distance the gauges may be equated, being read for considerable periods at the successive stations, with a short time intervening between stations.

A few remarks will be made on the detail of the method.

The gravel banks of the Saskatchewan in this District and the buoyancy likely to affect an insecure gauge both require that the gauge stick be shod with a heavy pointed iron. Two or at most three gauges may be set, marked to tenths, and in the work being carried on, the one may be considered a check on the other, as through lack of instrument men it may be inconvenient to have the zero checked by levels to temporary benches twice for each move. Two books are kept one by the Sounder, and Cook, independently.

Although the method as worked out is believed to be more accurate in periods of high water than the system of adjusting intermediate river levels by interpolation between widely separated gauges taken for the same dates, it is of course increasingly accurate according as the entire system

A P P E N D I X "D"

EXTRACTS FROM REPORT OF G. H. WHYTE ON FLOODS IN ALBERTA AND SASKATCHEWAN IN JUNE AND JULY 1915

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APPENDIX "D"

EXTRACTS FROM REPORT OF G. H. WHYTE ON FLOODS IN ALBERTA AND SASKATCHEWAN IN JUNE AND JULY 1915

Introduction. In 1915, the eastern slopes of the Rocky Mountains between the Crowsnest and Yellowhead Passes in Alberta and the adjoining prairie in that province and portions of its eastern neighbour, Saskatchewan, were subject to unusual precipitation which, during June, was exceptionally heavy, culminating about June 25th. This heavy precipitation caused the run-off for all streams in this area to be much above the average, and in June and July, caused floods on many of the streams.

High water on the streams of Alberta and Saskatchewan is usual at least once a year and is of two kinds, depending on the type of catchment area; the first kind, when the ice breaks up and the run-off of the winter snows of the prairies takes place, occurs usually in March; the second, caused by the run-cff of the snows of the mountains, in June or July. It is only occasionally that either of these periods of high water reaches the magnitude of a flood. Every few years on some minor streams and at longer intervals on the main arteries, floods of some magnitude occur which, while they may be augmented by the run-off of snow water, are caused by exceptionally heavy rainfalls in a short period of time over an already well saturated ground surface.

General Causes of the Flood of June-July, 1915. The causes of the large run-off over a short period in June, 1915,

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For complete report see Appendix No. 4, Report of Hydrometric Surveys (stream measurements) for Calendar year 1915, Dept. of the Interior of Canada.

can be classed under two general heads, namely:

(1) The heavy precipitation of that period.

(2) The conditions affecting the run-off.

Each of these two heads requires some discussion and while somewhat different, are also closely connected. That is, unless conditions were favourable for a speedy run-off of much of the rainfall, no such flood could have occurred. From the meteorological records it is seen that there were unusual amounts of rain in both May and June, 1915, and the rains of June 24th to 27th were of exceptional density at some points, therefore, no further discussion of the first head is necessary.

Under the second head, "The conditions affecting run-off", there are several sub-heads, namely:

a. Topography.
b. Geological structure.
c. Evaporation.
d. Vegetation.
e. Ground water.

The first of these, (a) "Topography", has, of course, a marked effect in changing rainfall to run-off. Steep slopes, as found in the foothills, and gentle slopes run off more than lands, such as prairies, which often have very slight slopes.

The (b) "Geological structure" of an area no doubt has some part in determining its run-off, but authorities seem to differ as to its importance. The areas under consideration in this report are, as far as run-off is affected, fairly similar in their geological structure and therefore need not be extensively commented upon. The upper beds of the mountain regions are for the most part of limestone series, although others are of quartzite, which in most cases has little or no soil cover. The foothills, on the other hand, are principally of sandstone and shale series which in general has an abundant soil cover. Full details of the geology of this whole area may be found in many reports on the geological features of the Rocky Mountains, or of various areas published by the Geological Survey of Canada.

The (c) "Evaporation" over an area is one of the most important points to be considered in a study of the run-off of precipitation. It depends on a great many other factors and is here taken to include direct evaporation into the air and indirect evaporation or absorption by plant growth. The amount of water evaporated into the air of course, depends on the temperature, velocity of winds and atmospheric pressure. Over the area covered by this report it is known that the temperature during both May and June of 1915 was below normal, and in June up to the date of the heavy rains there were few warm days. Therefore it is assumed that from the point of temperature the evaporation would be low. The velocity of winds over the areas from the records at Calgary and Edmonton was little above 1914 and probably about normal. Atmospheric pressure at Banff, Calgary and Edmonton was above that of the four previous years, and the effects that this condition would produce would favour low evaporation. The humidity was also greater in 1915 than in the two previous years. The absorption by plant growth would apparently not be as great in June as usual, as it was stated at that time that crops were backward, owing to the cool weather and great amount of rain. If the conditions were such on the prairies, where the mean temperature was about five degrees above the foothills and mountain section and the precipitation from two to eight inches less, it can be assumed that they were at least similar in the foothills and mountains.

From the foregoing it can be readily seen that the evaporation for May and June can be assumed as being below the average for those months, thus allowing more than the usual amount of rainfall to become ground water and run-off.

The (d) "Vegetation" of an area has a marked effect on the run-off and evaporation. A cover of trees with their matted roots forms an effective pondage for quantities of ground water and retards the run-off to a noticeable extent. They also protect the surface of the ground from the direct rays of the sun, reducing to some slight extent direct evaporation from the soil.

The presence of vegetation also has the effect of increasing evaporation by absorption into plant life and by exposure to the air of large quantities of moisture contained in leaves, much of which is evaporated.

It is seen, therefore, that forests and their plant life adjuncts have a retarding rather than an accelerating effect in converting precipitation into run-off. The foothills and mountains of Alberta are not well covered with tree growth owing to the repeated fires in past years. Better protection from fires is aiding the gradual development of forest cover, and as this cover extends, the effects of heavy rains should not be felt as quickly nor as markedly.

A proportion of all precipitation finds its way into the ground and forms that little known or understood part of hydrography called (e) "Ground Water". The earth's surface is penetrated to great depths by ground waters which are constantly in motion. Towards the surface these waters are affected in their motion by various conditions, such as changes in atmospheric pressure and temperature. In addition to the above, precipitation, which is the source of ground water, plays an important part in such motion. The motions of ground or sub-surface water, like surface waters, are vertical and horizontal, and the vertical motion is greatly affected by rainfall. The horizontal or sub-surface flow of ground water is a fairly constant factor, that is, the channels remain of a more or less constant size, and the only increase in flow is caused by increase of head. The upper soils of the earth are much more open than the lower and especially is this true where there is a good growth of plant life and these parts are subject to great changes in position of the ground water. When heavy rains take place the upper soils absorb great quantities of water which gradually filter through the lower strata. If the rains are continuous it can be seen sooner or later the surface stratum absorbs all the water it possibly

can, and as the lower strata cannot carry away the rain as fast as it falls most of it will have to run off on the surface.

South Saskatchewan River.

Description. This stream is formed by the junction of the Oldman and Bow Rivers at a point known as the Grand Forks in Alberta. It flows in a northeasterly direction through the eastern part of Alberta and almost across Saskatchewan where it joins the North Saskatchewan River forming the Saskatchewan River proper.

The river is joined by the Sevenpersons River near Medicine Hat, the Red Deer River just after it crosses into Saskatchewan and farther down by Swiftcurrent Creek, the Red Deer being the only tributary with much of a flow.

The whole of the drainage area of this river is prairie and from it there was little run-off in June to augment the flood discharges of the Oldman, Bow and Red Deer Rivers. It is therefore not necessary in this report to go into the causes of the flood, precipitation or temperature in the main drainage area.

Former Floods. This stream has been subject to floods of some magnitude on a number of occasions in the past few years, practically every flood on the three main branches causing floods or high water on the main stream. At Saskatoon on June 17th, 1908, the river reached a stage of 26.9 feet or 6 feet higher than in 1915. It is assumed by the city of Saskatoon that the flood of 1908 was the highest known at that point. At Medicine Hat it is believed that the flood of 1902 was the highest although no definite data are available. In 1908 the stream rose to within sixteen inches of the 1902 record. The 1908 record was 2142.68 feet above sea level (Canadian Pacific Railway datum). In 1897 a very high flood also occurred.

Progress of the Flood. It is difficult to determine what stream caused the peak at the lower stations. For

instance, it is hard to say if the maximum at Medicine Hat was caused by the waters of the Bow or Oldman River except by comparison of discharges. From them it would seem that the peak flood was caused by the Bow River and that it took twenty-four hours for the crest to pass the 168 miles between Bassano and Medicine Hat, at a rate of 7 miles per hour. The crest of the flood from the Oldman River apparently reached Medicine Hat about 9 a.m. June 28th, or at a rate of approximately 7 miles per hour. From Medicine Hat to Saskatoon, a distance of 400 miles, there is a difference of 108 hours for crests which would allow the upper water to travel at a rate of about 4 miles an hour. The crest from Medicine Hat, however, apparently reached Saskatoon 18 hours earlier or at a rate of 4.44 miles per hour followed by the crest from the Red Deer River. It took 131 hours for the Red Deer crest to travel 600 miles or at a rate of 4.6 miles per hour. Hourly gauge heights and discharges during the flood are given in Table B2 for Medicine Hat and B3 for Saskatoon.

Damage. There was little damage to property along this stream and there was no loss outside of some economic losses at Medicine Hat and Saskatoon.

The damage caused by floods may be divided into two classes - actual and economic. Under "actual damage" are classed direct physical losses that are tangible and apparent, a portion of which may be measured in terms of the expenditure required to restore the thing damaged to approximately its condition before the flood; the rest may be measured in terms of the monetary value of the thing lost or destroyed. Under the classification "economic damage" are placed those indirect losses that are, in a sense, presumptive. These include losses due to suspension of business and social relations in the flooded area and in places having such relations with that area; losses due to decreased confidence in the security of the localities flooded - especially the towns and cities, which may be termed lost prestige; losses due to general depression and decreased initiative throughout the flooded district; and losses due to a materially decreased property valuation. For a former use of these terms see page 86 of the Water-Supply, Paper 334, the Ohio Valley Flood of March-April, 1913, published by the U.S. Geological Survey.

North Saskatchewan River.

Former Floods. From the conditions prevailing on the headwaters in the two upper sections it is seen that the North Saskatchewan River is liable to floods of a greater or less magnitude, and during practically each June or July the stage reaches a point which can be considered a flood period or borders closely on such condition.

Previous to 1915 the worst flood in the past fifty years, and in fact as far as records or memory goes, took place in August, 1899.

At that time the river reached a height equal to 41.37 feet on our gauges at Edmonton, or an elevation of 2034.75 feet, Public Works of Canada datum. This height gave a discharge of approximately 180,000 sec.-ft. from an estimate by Kutter's formula. At Prince Albert the gauge height reached was equal to 25.9 feet on the gauge or an elevation of 1481.997 feet, Public Works of Canada datum. This height gives a discharge of 160,000 sec.-ft. by Kutter's formula.

Stories at Prince Albert and Edmonton give records of higher floods, but both seem to have been caused by ice jams in the spring. The jam at Prince Albert is alleged to have taken place some 35 or 40 years ago, while that at Edmonton took place over 80 years ago.

In 1900 the river reached a gauge height equal to 37.9 feet on the gauge at Edmonton and did considerable damage. Since August, 1907, we have fairly continuous records, and the highest gauge height reached was 26 feet on July 10th, 1912, the discharge on this date being about 75,000 sec.-ft.

During the floods of 1899 and 1900 considerable damage was done all along the river, but no actual figures are available. In 1899, the low-level bridge at Edmonton was in process of construction at the time of the flood and it was found necessary to raise the piers eight feet higher than at first proposed so as to provide for floods of such magnitude. The water reached to within one and one-half feet

of the tops of the present piers at that time.

The cause of the flood of 1899 is rather hard to decide, but in the writer's opinion it can be accounted for by the excessive rains rather than by the melting snows. The meteorological records at Edmonton for August, 1899, gave 6.43 inches of rainfall or 4.63 inches above the monthly mean. The mean temperature was 55.7% or 3.3^{o} below the monthly mean. It is very probable that these conditions prevailed to a greater degree in the two upper sections. It is usual to find that the snow has practically all melted by August and as rises had taken place in June and July of 1899 it is probable that this condition prevailed in that year. Therefore the assumption that this flood was caused by rains is borne out. During the whole summer the entire basin had a very heavy rainfall and in the two upper sections this rainfall would be stored to a certain point when it would run-off very rapidly and add much of the stored water to the exceptionally heavy rains of August.

Causes of Flood of June-July, 1915. The direct cause of this flood was no doubt the heavy rainfall between June 24th and 27th on the already thoroughly saturated drainage area. This rainfall was especially heavy on the upper sections of the basin and in the three days there were fifty-eight hours of continuous rain and the fall is estimated at approximately six inches by Mr. O. H. Hoover, of this staff, who was on the headwaters of the main stream at that time. This precipitation on a country which at best does not retain much of the rainfall and which had already been thoroughly saturated by the heavy rains throughout the earlier part of the month caused sudden and excessive run-offs in a short period. The run-off from rain was added to by the rapid melting of the snows at this time.

Owing to the cloudy cold weather early in June the snows of the upper peaks did not melt as readily as ordinarily, and there was more than the usual amount of snow lying on the upper peaks on June 24th. Fortunately the snowfall during the

winter of 1914-15 was rather below the average.

An idea of the run-off of the upper section at this time can be gained by a study of the maximum discharge of some of the smaller streams in this locality. A very good example is the Mistaya River, a stream with a catchment area of some 130 square miles and on which there are six lakes which regulate the flow to a great extent. This stream reached a maximum discharge of 2,200 sec. ft., on June 27th, or 17 sec. ft. per square mile of drainage area. At Wilson's ranch on the North Saskatchewan River in Tp. 36, Rge. 18, W. 5th Mer., the maximum daily flow was 21,000 sec. ft. with a catchment area of 836 square miles. This works out as a run-off of 25 sec. ft. per square mile or 0.93 inches over the drainage area for one day. While these run-offs are by no means records they are high for the eastern slope of the Rocky Mountains in Alberta.

Precipitation and Temperature. Owing to the lack of settlement on the headwaters of the North Saskatchewan River, meteorological stations are not maintained and, therefore, no official records are available.

During June Mr. Hoover reported that there were eighteen days of rain and that during the whole of the early part of the month the temperature was low and the weather cloudy.

At Mountain Park (on the headwaters of the Macleod River at an elevation of 3,891 feet above sea level), the records for June show the mean temperature at 45.2 and the total precipitation as 12.26 inches with a maximum of 3.35 inches on a single day. There were twenty-one days on which 0.01 inch or more fell, and nine fair days. At Banff (on the Bow River at an elevation of 4,534 feet above sea level) the records for June show the mean temperature as 50.2 or 1.1 degrees below the mean of twenty years, and the total precipitation as 6.05 inches or 2.86 inches above the average with a maximum fall of 1.97 inches on a single day. There were twenty days with 0.01 inch of rain or more, and ten fair

days. As the mountains on the headwaters of the North Saskatchewan drainage lie midway between these two stations it may be assumed that a mean of their records could be assumed as an average for this part of the basin. The mean temperature thus obtained is 47.7° and the total precipitation 9.16 inches. Using in addition the records obtained at Red Deer (which is to the southeast of the headwaters of the North Saskatchewan) and those at Edmonton (on the northeast of the headwaters of the North Saskatchewan) we find that the mean temperature was 50.3 degrees and the mean total precipitation was 7.14 inches. As the catchment area of the headwaters of the North Saskatchewan River lies within the trapezoid bounded at the corners by Banff, Mountain Park, Edmonton and Red Deer, the records for these points should give a very fair average for the whole area.

Progress of the Flood. The most westerly streams rising in and draining the main range of the Rocky Mountains started to rise during the night of June 24-25 and reached their maximum about noon June 27th. Those streams draining large areas east of the main range started to rise during the day on June 25th and reached their maximum about 10 a.m., June 27th, or about the same time. This allowed the drainage of the lower altitudes to pass off before that of the higher reached the main stream.

The crest of the main stream reached Rocky Mountain House about 2 a.m., June 27th, with a stage of 23.38 feet and an estimated discharge of 145,000 sec.-ft. At Rocky Rapids the crest arrived about 10 p.m., June 27th, and Edmonton about 11 p.m. June 28th, with a stage of 45.04 feet or 3.75 feet above any previous known stage and with an estimated flow of 204,500 sec.-ft. Battleford was reached about 5 p.m., June 30th, Ceepee about 6 p.m., July 1st, and Prince Albert at 1 p.m., July 2nd, with a stage of 26.42 feet, or 0.5 feet above the previous highest record, that of 1899, and a maximum discharge of 200,000 sec.-ft.

The rate of progress of the flood seems to have varied very greatly. From Wilson's ranch in Tp. 36, Rge. 18, W. 5th Mer., to Saunders' siding in Tp. 40, Rge. 13, W. 5th Mer., a distance of fifty miles and an approximate fall in elevation of 13.4 feet a mile, it took some six hours, or at a rate of 8.33 miles per hour; from Saunders' siding to Rocky Mountain House, a distance of forty-five miles, with a fall of 12.5 feet per mile, it arrived some twenty-one hours earlier. This was no doubt due to the flood on Sheep and Clearwater Rivers arriving before that on the main stream. From Rocky Mountain House to Rocky Rapids, a distance of 80 miles with a mean fall of approximately 5.5 feet per mile, the crest took twenty hours, or at a rate of flow of four miles per hour; from Rocky Rapids to Edmonton, a distance of 102 miles, and a fall of 6.6 feet per mile, it took twenty-five hours, or a rate of flow of 4.1 miles per hour; Edmonton to Battleford, 320 miles, with a fall of 1.6 feet per mile, forty-two hours, or a rate of flow of 7.6 miles per hour; from Battleford to Ceepee, sixty miles with a fall of 0.9 feet per mile, twenty-five hours, or a rate of flow of 2.4 miles per hour; from Ceepee, to Prince Albert, 98 miles, with a fall of 0.9 feet per mile, nineteen hours, or a rate of 5.2 miles per hour; from Battleford to Prince Albert, a distance of 158 miles, forty-four hours or at a rate of 3.6 miles per hour; from Edmonton to Prince Albert it took eighty-six hours to travel the 478 miles, or at a rate of 5.56 miles per hour.

Damages. The total damages caused by the flood are hard to accurately arrive at owing to the impossibility of making an accurate and exhaustive survey of such damages.

Above the mouth of the Clearwater River the only damages were to trails and to the grade of the Canadian Northern Railway (Brazeau branch). These losses would total to at least $30,000, principally to the railway whose grade was destroyed in a number of places. On the Clearwater River a new traffic bridge, about two miles from the mouth, was completely destroyed

with a loss of $2,500. At Rocky Mountain House the ferry was destroyed as well as the cable station of this branch. The cost of replacing the ferry was some $1,000 and the cable station some $150. The cable station at Rocky Rapids, owned by Sir John Jackson Company (Canada), was taken out, and it is estimated that it will cost at least $1,000 to replace it. The greatest amount of damage done was at Edmonton where the direct losses are estimated at from $500,000 to $750,000; the loss to the municipality being $17,500 caused by damages to sidewalks, roads and other property; the balance of losses being due to the inundating of the lower parts of the town known as Fraser, Ross and Mill Creek and Callagher flats, the washing away of the Edmonton Lumber Company's Mill and the destruction of booms belonging to the Edmonton Lumber Company and the Walters' Mills. Many homes were destroyed and the damage to hundreds of others and their contents was very great. It is estimated that eight hundred families were rendered homeless by the flood. The loss of life was fortunately very light, the only casualty being an infant which was dropped by its mother from a floating side walk into the flooded street. The river began to flood over its banks at gauge height, 35.0 feet, at Edmonton and thus there was a depth of 10 feet of water at some points on the flats. The city electric light and pumping plants at Edmonton were out of commission for some hours owing to flooding of their boiler fires and this caused considerable inconvenience to numbers of business and residents in the higher parts of the city.

The damage to property along the river below Edmonton was not very great, a few farms along the flats were inundated and at Battleford several houses were flooded. At Prince Albert the principal damage was due to losses of logs which was well under $10,000.

At Edmonton the low level bridge was in danger owing to debris such as buildings, sidewalks, logs and roots collecting on the piers and bridge stringers, but this structure was saved

by clearing this debris away and by placing a loaded train on the bridge. The same procedure was carried out at Prince Albert where much debris collected on the piers. At Ceepee, the Canadian Northern Railway bridge approaches were damaged to some slight extent.

It is probable that the total actual damage on the whole stream amounted to between $750,000 and $1,000,000. In addition to the damage to property the stream channel at many points was completely changed. Banks and low flats were washed away and deposited at different points along the river and there is probably little of the river bed which was not changed to some extent. In general the river channel has been enlarged which will provide more room for such floods if they occur in the near future.

APPENDIX "F"

HISTORICAL

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APPENDIX "F"

HISTORICAL

The following is reproduced from Mr. A.H. de Tremaudan's Book "The Hudson Bay Road" (J.M. Dent & Sons, Limited, London and Toronto, 1915):-

THE SASKATCHEWAN RIVER.

At Winnipeg, on July 12, 1910, the Honourable Mr. Pugsley, Minister of Public Works in the Federal Government, who was accompanying Sir Wilfrid Laurier in his western tour, was the first public man to refer to an important though purely western transportation problem intimately connected with the Hudson Bay Railway. He said: "Nature has provided right at your doors a great river running down into Lake Winnipeg, a Lake that is greater than Lake Ontario. The River Saskatchewan rises some 1,300 miles to the westward, in the foothills of the Rockies. I am one of those who believe that with a reasonable expenditure of money, it will be possible to create a great system of inland navigation extending from the city of Edmonton and beyond, right down for 1,300 miles to this great city."

Two days later, at the opening of the St. Andrews locks, on the Red River, connecting Winnipeg with the Lake, Sir Wilfrid had the following to say on the subject: "We have opened the Red River up to Lake Winnipeg and it now remains for my friend Dr. Pugsley to open the Saskatchewan River from Edmonton to Winnipeg. I am glad to say that my friend, the Minister of Public Works, is already at this work. He has

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"I have the greatest possible confidence that in the immediate future a great traffic will be developed on the Saskatchewan River between Edmonton and the Pas, on the line of the Hudson Bay Railway leading to the Nelson River." - Hon. Robert Rogers, Minister of Public Works, at Edmonton, September 1913.

engineers in the field surveying the Saskatchewan River, and before many years are over I hold that we shall witness such a thing as has been witnessed to-day - that is to say, the opening to navigation of the Saskatchewan River up to the city of Winnipeg; and if God spares me, and if the Grace of God and the will of the people keep me where I am, I am sure that I shall see the day when a barge laden with coal at Edmonton, nay, at the very foot of the Rocky Mountains, will be unloaded at Winnipeg without breaking bulk on the way."

These two utterances were no doubt in answer to the resolution passed by the Associated Boards of Trade of Western Canada, a month earlier, "urging the improvement of navigation of the Saskatchewan River."

In 1895 Mr. John Ross, who built the north shore line of the Canadian Pacific Railway, had written: "When the population of these territories comes to be counted by millions and tens of millions, as in course of time it will be, all the railroads likely to be built would not suffice to carry their surplus productions to the ocean at least at such rates as would be satisfactory to agricultural communities. But through these wide regions Nature has provided a highway for cheap transportation, which can, at an outlay which the government might well bear, be rendered available."

With the advent of the railway, and the settling of the southern portions of the western provinces, what had been the principal highway of the traders and explorers since la Verendrye's sons had discovered it in 1741, the River Saskatchewan, had been more or less forgotten. Only the Indians with their birch-bark canoes and the Hudson's Bay Company with its York boats, steam vessels, and barges had continued to navigate its waters, from Edmonton on the North Branch and Medicine Hat on the South Branch to Grand Rapids on Lake Winnipeg. As soon as the Hudson Bay Railway became a possibility of the near future, it appeared evident that

this immense waterway of the old trading days should again be utilized, this time in transporting the grain of the western plains to the Pas, the south terminus of the new projected railway.

The Peace River country was just commencing to attract the attention of the settler, offering the same advantages for colonization that Manitoba and the south portions of Saskatchewan and Alberta had offered since the opening of the country by the Canadian Pacific Railway. On account of the remoteness of the district from the eastern markets and the consequent high cost of transportation, it seemed reasonable to expect that the settler would be encouraged in the task of opening these last immense plains by an effort to give him a means of transportation with the help of which he could complete successfully against the excessive charges which would necessarily be made by the railways entering the new territory.

As early as 1858 the government of Canada, which was already looking with envy at the North-West Territory of those days over which the Hudson's Bay Company held sway, had sent an expedition to, among other objects, survey the River Saskatchewan with a view to study its navigability. Dr. Henry Youle Hind, M.A., professor of chemistry and geology in the University of Trinity College, Toronto, had been placed in charge. His report, published the following year, is one of the most extensive works on the subject, and, to this day, remains an authoritative record. The exploration, however, did not extend to the North Branch of the river, which, from all precedent reports handed down from the days of Henry and Thompson, had proved, beyond doubt, to be the more navigable of the two branches.

Hind thus describes the South Branch and the main river:

"The south branch of the Saskatchewan is a noble river, varying in width from half a mile to three hundred yards, for a distance of 100 miles from the Elbow; it then gradually

contracts its channel and changes its character from a river full of sand-bars and mud-flats, pursuing a comparatively straight course, to a rapid and uniform torrent of water, sweeping down the narrow but deep valley it has excavated, from one bank to the other in magnificent curves, until it joins the North Branch ...... The main Saskatchewan is a river of very imposing magnitude. Like the South Branch, it occupies a narrow, deep valley, varying in width from 1½ to 3 miles, extending a few miles below the Nepoween Mission. It flows in grand curves from side to side, and its general level is about 300 feet below the country through which it has excavated its channel, after which it enters the low region."

"About 158 miles below Fort a la Corne, near Tearing River, the main Saskatchewan is 330 yards broad, 92 feet deep in the channel, has a mean sectional depth of 20 feet, and flows at the rate of 2 miles an hour. 291 miles below the Grand Forks the main Saskatchewan enters Cedar Lake, 30 miles long. Issuing from this large body of water, it expands into a small lake, but soon again contracting its channel, the Cross Lake Rapids come into view; these rapids have a fall of 5¼ feet. Hudson's Bay Company's boats of 4 or 5 tons are tracked up them with half cargo, but loaded boats descending run the rapids. The length of the portage involved in ascending the river is 230 yards. The Saskatchewan now enters Cross Lake, and after issuing from this elongated expanse of water, begins a rapid course to Lake Winnipeg, with a current often 3 and sometimes 3½ miles an hour. The head of the Grand Rapids is about 4 miles from the mouth of the river. The length of the portage is 1 mile 7 chains. The rapids below the portage are about 1½ miles long, so that the total length of the Grand Rapids exceeds 2½ miles. The fall from the west to the east end of the portage, as ascertained by levelling, is 28½ feet. The fall below the portage is estimated to be 15 feet, consequently the total fall is about 43 feet."

In the course of his report, the author, in connection with the discoveries of gold in British Columbia, shows how, until the construction of a railway, the great Saskatchewan River seems to be the natural highway between the valley of the Mississippi on one hand, and the St. Lawrence Valley by way of Lake Superior on the other, with the province of the Pacific slope of the Rocky Mountains. Already parties of American emigrants coming from St. Paul had been met, which were proceeding to Frazer's River via the North Branch, instead of by the Missouri route, which was considered more hazardous. A company, calling itself the Canadian North-West Transportation Company, was proposing to put in a line of steamboats between the Red River as far as St. Paul and the North Saskatchewan, with a possible connection with Lake Superior by the Lake of the Woods. "In these projects, so rapidly approaching completion, the North Branch of the Saskatchewan is the route to be followed to British Columbia. In a word, public attention seems to be almost exclusively directed to Lake Winnipeg and the North Branch."

As to the South Branch, the diversion of its waters down the Qu'Appelle Valley would make a communication for steamers possible from Fort Garry to near the foot of the Rocky Mountains, by way of the Assiniboine River; for this, a dam 85 feet high and 600 to 800 yards long across the South Branch, below the point of its junction with the Qu'Appelle River would easily be protected from any possible resulting flood by means of a shallow cut through the gentle rise separating the Assiniboine from the Rat Rivulet, which would permit the excess waters to flow into Lake Manitoba.

While the project of the South Branch via the Assiniboine and Qu'Appelle Rivers has since been abandoned, the other has been mentioned from time to time, principally during the last few years. The main difficulties are the Grand Rapids, at

the point where the main river flows into Lake Winnipeg, and where a canal with locks has to be built, and the Coal Falls on the North Branch, just above the Grand Forks, where 18 miles of rapids obstructed by boulders, many of which are exposed during low summer levels, create serious engineering problems. These, however, may be in part solved after the construction of the big power dam being presently erected by the city of Prince Albert at that point.................................. ......The importance of the navigation of the two Saskatchewans in connection with the Hudson Bay Railway will be readily seen. Water routes being recognized to be so much cheaper than railways, barges laden with wheat may be floated down these two rivers, at an immense saving, to the Pas, there to be unloaded into the Hudson Bay trains for the last 424 miles of the inland route.

The immense possibilities of the project have made a writer, in one of the numbers of the CANADIAN MAGAZINE, in 1911, exclaim with considerable appropriateness and foresight: "The future of the Saskatchewan is assured. To-day the Peace River country is on the eve of its development; to-morrow, as a new province, it will be sending its wheat to European markets by the cheapest and shortest route. And what is that route? Beyond all doubt, it is by way of the Saskatchewan River and Hudson's Bay. The expenditure of a few million dollars would make the river safely navigable as far as the Pas, where waiting trains would whisk the golden grain to the hold of transatlantic steamships. This is not a dream, but a prophecy. Railways may scoff, but the fact must soon be faced; the Saskatchewan is again coming into its own."

In the expectation of the traffic which should take place in this connection at the Pas, the Federal Government is now spending several thousand dollars in dredge work and on a wharf. What has been to this date the most important

inland port between Winnipeg and the Rockies thus sees another impetus given to its already advantageous geographical position.

With time and the spending of several more million dollars it may be reasonably expected that the navigation of the Saskatchewan River, in relation to the Hudson Bay route, shall not stop at the Pas, but that it shall be continued past the Grand Rapids northward on Lake Winnipeg to Norway House and down the Nelson River, provided with a system of canals around its numerous rapids on the 200 odd miles where it is not now navigable, on to Port Nelson. The dream of Sir Wilfrid Laurier, in which he saw an immense waterway from the foot of the Rocky Mountains to Winnipeg, forsooth to Quebec via the Lake of the Woods and the Great Lakes, will then not only be realized but exceeded to the extent of making several western cities seaports in miniature, in which the products of the farms may be loaded in barges which will only be transhipped to the transatlantic vessels at the terminals of the Hudson Bay route. Imagination may even go one better and picture to itself the ironclad monsters steaming along the different rivers of the Nelson basin, far inland, for or with their cargoes. In the meantime, on March 5, 1912, an organization called the "Red River to the Hudson Bay Navigation Association" with Mr. R. D. Waugh, then Mayor of Winnipeg, as president, was formed at Grand Forks, in North Dakota, for the purpose of advocating the creation of an all-water route to Hudson Bay; which may serve to demonstrate that the scheme is not all dream for some enthusiastic westerners.

It may be safely said, however, that many generations will pass before the immense difficulties along the Nelson River will be surmounted. Indeed, what is required, except possibly for the 60 miles between Cross Lake and Manitou Rapids, is a continuous canal. Even that will be found hardly sufficient on account of the rapid drop towards Hudson Bay. As an example, it may be stated that reliable engineers in the employ of the Hudson Bay Railway have figured on the necessity of providing no less than twenty-seven locks to go through Gull Lake alone,

"With the advent of the iron horse the west went railroad mad," some one has said very pointedly. This madness will pass away and the rivers will again have their days of usefulness as the most natural highways of commerce.

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a mere expanse of the Nelson River. As one of them puts it: "A season would not be sufficient to carry a boat from Port Nelson to Lake Winnipeg." Of course, it is difficult to picture to one's mind the millions which would have to be spent to build this gigantic canal from lake to bay. The possibility of a continuous navigation from Port Nelson seems to be wholly of the domain of conjecture and utopia.

FROM MANITOBA FREE PRESS

"THE" or "LE" - WHICH?

The following communication has reached the FREE PRESS in regard to the name of the new town which is the centre of the lately acquired extension of the territory of Manitoba:

"Having noticed lately that some despatches from the southern terminus of the Hudson Bay Railway were headed The Pas (pronounced Paw), the reappearance of this hybrid name has set me wondering why this form, which I thought had been finally abandoned, should again find people willing to employ it. I have taken the trouble of studying most fully documents, historical and traditional, bearing on the subject, and I now take the liberty of asking you, Mr. Editor, to kindly open the columns of your valuable journal to the few facts and remarks which I have gathered on the subject, as well as the only natural conclusion which, in my opinion, can be reasonably arrived at.

"When, last January, the inhabitants of the new northern metropolis, Le Pas, were asked to vote on a money by-law providing for the expenditure of $120,000 on sewers and water-works, there was not one single vote registered against the proposition. This established a new record in such matters in Western Canada, and showed how well united the people of that town are. There is only one point, apparently, on which opinions differ, and which causes a little friction between the two camps in which the population is on this account divided. That is whether "Le Pas" or "The Pas" should be the name of the south terminus of the Hudson Bay Railway.

"In view of the considerable attention which this town has attracted for the past eighteen months, a short and impartial study of the subject should not be amiss.

"As far as modern history goes, Le Pas dates back to 1840. In that year, Rev. Henry Budd, an Indian catechist from York Factory, founded there a Church of England mission, which was known successively as Devon Mission, Cumberland Mission and Pas Mission. On his arrival he had found the placed called "Le Pas de la Riviere" and evidently found it ultimately necessary to preserve this name, although with the help of the Hudson's Bay Company it was Anglicized into the form The Pas. The tombstone of the Indian preacher is still to be seen in the old cemetery by Christ Church, at the northern end of Fischer Avenue. The inscription on it reads as follows: "Sacred to the memory of the Rev. Henry Budd, who died April 2, 1875, aged 61 years. Named after one of the founders of the C.M.S. The first Indian convert and clergyman in Rupert's Land. An earnest and faithful minister of the gospel for 25 years. Beloved by the flock over which he was pastor."

"From that time to about 1895, the place continued to be known as The Pas and Pas Mission among the English-speaking element of the population, and Le Pas among the French-speaking people. In that year a post office was established to which the name The Pas was given.

"In 1908, the Canadian Northern Railway named its station Le Pas, and in 1911 the post office department followed suit and changed the name from The Pas into Le Pas. The same fall the local newspaper, the HUDSON'S BAY HERALD, was established, which naturally adopted the name used by both the railway and the post office department. In the spring of 1912, a deputation went down to Winnipeg to obtain the incorporation of the town under the name of The Pas, which was granted, although the new electoral district formed of Manitoba's new territory had been previously called Le Pas. Those who are in favour of the French form say that in doing this the members of the deputation overrode their instructions, as the mandate they had received

did not authorize them to unnecessarily change established conditions.

"Two stymologies are offered as to the word "Pas". Those who are in favour of the form "The Pas" say that it is a contraction of the Indian word "opasquiaow", which, they explain, means water converging to a narrows, with high land and spruce trees on either side. Those who stand for "Le Pas" rejoin that, if it be so, it should be pronounced "The Pass", since in the Indian word the "s" is sounded, and they offer the counter explanation that 'pas' is a French word which means 'narrow passage', as employed in the well-known geographical terms, Pas de Calais, Pas de Roland, Pas du Loup, etc. In fact, the Indian and French meanings do not differ materially, both are perfectly descriptive of the aspect which is characteristic of the Saskatchewan River at Mission Island, where the Hudson Bay Railway bridge has been erected. It must be admitted, at any rate, that if the word 'pas' is a contraction of the Indian word 'opasquiaow', it is at least pronounced after the French fashion. In English, even if understood in the sense of dance step, as used by Chaucer, the correct pronunciation should be 'pass'.

"But the history of that place goes much further back than 1840, and it is there that the French etymologist finds his most weighty material. I believe that your readers will find the facts that I am going to rapidly enumerate, interesting and given in an impartial manner, although, favouring the French form and believing that it is better known by the public at large than the English form I shall continue to use Le Pas in my narrative.

"To Chevalier Pierre and his brother Francois, sons of the now famous western discoverer, Pierre Gaultier de Varennes, Sieur de la Verendrye, is generally ascribed the honour of having discovered the Saskatchewan River, which they ascended

as far as the forks in the fall of 1741. Before them Henry Kellsey had taken a trip southwest of Port Nelson as early as 1691, but it is not probable that he went as far south as the Saskatchewan River, and in 1739, a French half-breed by the name of Joseph La France, a native of Michili Makinak, on Lake Huron, had set out for Hudson Bay, and finally spent the winter of 1740-41 near Le Pas, on Saskar 'm Lake. It seems, however, impossible to verify the stories of Robson and Dobbs, and for this reason most historians do not mention them.

"Leaving their father at Fort de la Reine(Portage la Prairie), the two younger la Verendryes had started northward, discovering Lake Manitoba, on the west side of which they had founded Fort Dauphin, subsequently reached the Saskatchewan River, established Fort Bourbon on the west end of Cedar Lake and Fort Poskoiac, where Le Pas is today.

"According to most reliable historians such as Rev. E. Petitot, laureate of the Geographical Society of London, and Rev. A. G. Morice, member of the Historical and Scientific Society of Manitoba and British Columbia, and who is admitted an authority on western history by Catholics and Protestants alike, the two younger la Verendryes named that part of the Saskatchewan River flowing between the Junction point of the north and south branches above Fort a la Corne and Le Pas, Riviere du Pas, out of devotion to their mother, Marie Anne Dandonneau du Sable de l'Islo du Pas, daughter of the marquis of that name. In support of this version, Rev. E. Petitot states that during his trip up the river in 1862, on arriving at Le Pas, his French half-breed guides exclaimed on sighting the wide expanse of the Saskatchewan River: 'La Riviere du Pas' 'And the Saskatchewan'. 'There is no river of that name. This is the Riviere du Pas; we know of no other. This opinion is confirmed by John M'Lean, who in his notes of a 25 years' service in the Hudson Bay territory, published in 1849, wrote:

'We arrived on the 5th of August (1833) at Riviere du Pas, where an old Canadian, M. Constant, had fixed his abode, who appeared to have an abundance of the necessaries of life, and a large family of half-Indians, who seemed to claim his as their sire.'

"Dr. Bryce says that la Verendrye's sons shortened the name of the river, which was 'Paskoyac', to 'Pas'. James Settee, a minister of the gospel at Cumberland House, says that the French-Canadian half-breeds called the Saskatchewan River 'Riviere du Pas'. He has lived in the country for years, and before him his father and mother lived in it.

"In my opinion, however, it seems strange that if this name were given to the Saskatchewan River by the two younger la Verendryes, it should not be mentioned on the map which was on their return prepared by their father, and on which it seems evident that the Saskatchewan River from Le Pas is named Baskoia. On the other hand the map may have been prepared in the absence of the two young men, and on their data, while they were away on further discoveries. This would not have prevented the name 'Riviere du Pas' being preserved among the French half-breeds, who had heard it employed by the two la Verendryes and the men in their party.

"In 1763 when Canada was ceded to England by the Treaty of Paris, of the French traders and missionaries who had accompanied or followed the La Verendryes on their trip up the Saskatchewan, there were hardly any left, they having returned to Quebec to take part in the fight which culminated in England getting possession of almost half a continent. The result was that the French language almost disappeared from the land, being retained only by the Metis and some of their Indian allies. Later, however, about 1783, the Scotch merchants who had commenced hiding away to the Far West as early as 1760 again employed the 'Coureurs des Bois' and 'Voyageurs' in their

expeditions, and as all their men spoke French among themselves, the French expressions as well as names of places were retained, for some time, at least. In some cases, however, they were unable to account for the meaning of some of them, and so Riviere du Pas degenerated into Le Pas de la Riviere, these men, no doubt, imagining that the name had been given on account of the narrow passage at Mission Island.

"No one will try to deny that French was very much in use among the Scotch merchants, who, as soon as they were able to get them, used none but French-speaking employees, on account of their being better adapted, by years of residence in the country and contact with its Indian population, to the hardships of the fur trade. This is evidenced by the terms used even in the reports of these merchants. M'Tavish, of X.Y. Company, in 1779, was nicknamed 'Le Premier' or 'Le Marquis', while such appellations as 'Les Petits', 'La Petite Compagnie', 'Pot au Beurre', 'Cantine Salope', 'Mangeurs de Lard', 'Le Rouge', 'Le Blanc', 'Le Borgne', 'Le Picote', 'Les Vachers', etc. were quite common.

"It would, therefore, be quite unreasonable to deny that Le Pas is undoubtedly much older than the hybrid form, The Pas.

"Another feature favouring the form Le Pas is the fact that about 1800 a French-Canadian and native of Three Rivers, named Constant, settled on the point where the town is now located, cleared the ground of the trees that were there, and started farming. According to his grandson, Antoine Constant, the present chief of the Indians of the Pas reserve, from whose lips this information has been obtained, Constant married a Sauteaux woman, who gave him two boys and four daughters. The present chief's father, whose name was also Antoine, married a Cree woman, who bore him five boys and four daughters. Now, to any unprejudiced person, the question is asked: Is it likely that the first Constant, who was probably one of these coureurs des bois or voyageurs, above mentioned, would

have called Le Pas anything but Le Pas? Is it reasonable to imagine that he may have called it The Pas?

"The remark has been made that The Pas has been in use by the government on its maps and in its reports, principally those emanating from the Indian Department. This is not denied, but the same may be said of Le Pas. For example, Le Pas is to be seen on the official plan of township 56, range 26, W. 1st M. In his booklet, THE HUDSON BAY ROUTE, published in 1908 by direction of the Department of the Interior, J. A. M'Kenna uses the form Le Pas. In the 1912 report of Indian Inspector Jackson and Indian Agent Fischer, Le Pas can be read. As a matter of fact, both terms have been employed, chiefly recently.

"The object of this article is to give the facts just as they are found and without partiality. In conclusion, the writer might be permitted to make the following remark; We British should be satisfied with having conquered this part of the world. In this, imitating our cousins of the United States, we should be willing to let the places which remind one of the early history of the country retain the names which are so characteristic of its early settlement by the European nations, and not grudge to a nation with whose people we are now allied the satisfaction of bringing back some of its ancient history, when this satisfaction does not extend beyond the naming of place. Let us be generous, and so long as tradition does not conflict with common sense, let us permit the right to our French co-citizens to retain even so little a share in the building up of our great western country. They have been at the battle; why refuse them their place at the triumph: The victor is worthy of the spoils. - Yours truly,

"FAIR PLAY"

"Winnipeg, May 15, 1913."